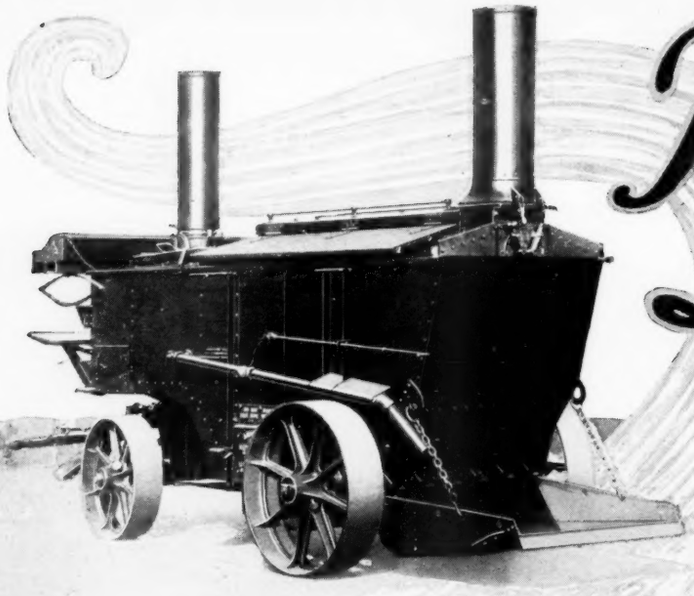
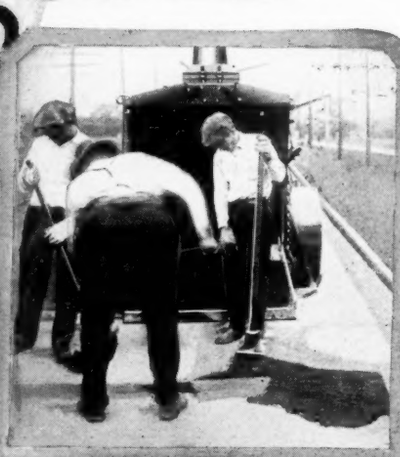
PUBLIC WORKS

CITY COUNTY STATE

FEBRUARY, 1928



Patches that Last



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THE AUSTIN-WESTERN ROAD-MACHINERY-CO. CHICAGO

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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 February, 1928 No. 2

Vehicular Tunnels Through Missionary Ridge

Twin tubes give Chattanooga additional access to the east and south. Landslide at portal and alternations between rock and clay in material tunneled cause difficulties.

By G. R. Kavanagh

The city of Chattanooga, Tenn., is situated in a bowl like formation, being surrounded by Signal Ridge, Missionary Ridge and Stringers Ridge, with Lookout Mountain just south of it. Access to it from beyond these ridges is had by tunnels, both railroad and vehicular.

The two present vehicular tunnels, one through Stringers Ridge to the north and west, and another under Missionary Ridge to the east and north-east leading to Georgia, are becoming so overloaded that additional facilities are necessary. After much discussion it was decided to build a tunnel through Missionary Ridge, parallel to the present tunnel and located about one mile south and west of it. Such an entry would furnish a means of routing traffic from Chattanooga, St. Elmo, and Rossville, Ga., to all of the present territory served by the other tunnel, as well as opening a shorter and more convenient route to Georgia.

Property owners adjacent to the proposed right of way donated the neccessary land for the approaches because of the expected appreciation in land values after the completion of the tunnel.

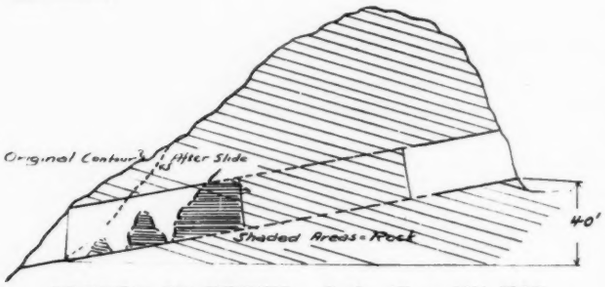
On the city side, the portals are located about one-half way up the side of Missionary Ridge in order to reduce the heavy grade through the tunnel necessitated by the difference in elevation of the terrain on the opposite sides of the ridge. Even with this arrangement, a 4 per cent grade, rising from west to east, is required. At the west end of the tunnel the road is divided into two, almost at right angles with each other, which drop down the mountain on an easy grade; one approach leading to Chattanooga proper and the other to Rossville and the southern sections of Chattanooga by a direct route.

HEADING, SHOWING CREW ON BENCH AND SIDE-DRIFTING

The location of the portal was so chosen that, as the motorist leaves the Chattanooga end of the tunnel, a view of tree-covered slopes and well-kept residences meets his eye, and in the distance can be seen Lookout Mountain, Signal Mountain and the Tennessee river winding past the city. Considerable attention was paid to the scenic effect, and the height of the tunnel portal is such that a bird's eye view of the city is obtained.

The approaches are so arranged that there will

be no cross traffic at the entry, or on up grades. The vehicles travelling down grade and out of the tube will be responsible, and if desiring to turn left through approaching traffic, will have to await a traffic signal. Other cars have right of way at all times.



PROFILE OF TUNNEL. Scale 1" = 450' HOR. AND 90' VERT.

The original plans called for a single tube tunnel to accomodate traffic in both directions, which is practically a duplicate of the present tunnel. These plans were approved and preparation was being made to receive bids on the work when it was suggested that twin tubes be built. This met with much opposition, but alternate bids were finally asked on each type of boring. Though many contractors declared that this plan was unwarranted, it was found, when bids were received, that the successful bidder would construct two 22-foot tubes, with a 25-foot pillar between, complete for $347,218. The same contractor made a bid of $540,202.50 on a single large tube of similar capacity.

The unusual economy of construction is due to the fact that, because of the design of tunnels, the actual volume of two small tunnels is much smaller than that of one large tunnel, having the same capacity as the two combined, and unit costs are lower where small bore tubes are constructed.

Each of the two tubes will accomodate two lanes of traffic, enabling the rapidly moving vehicles to pass the slower and maintaining at all times uni-directional traffic and draft for ventilation. As lights will be required on cars passing through the tunnels, troublesome glare occurs when traffic is moving in both directions in the same tube, and the two tubes will eliminate this factor.

Each tube will be about 1000 feet long. At present only 200 feet on the east end, and 300 feet on the west end have been driven.

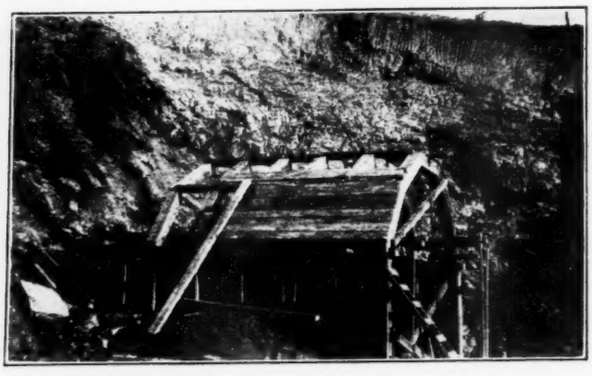
CONSTRUCTION

An Erie shovel was used for making the open cut immediately in front of the portals, being discarded for the smaller iron mules, mounted on Fordson tractors, and Ingersoll-Rand air drills after actual tunnelling work was started.

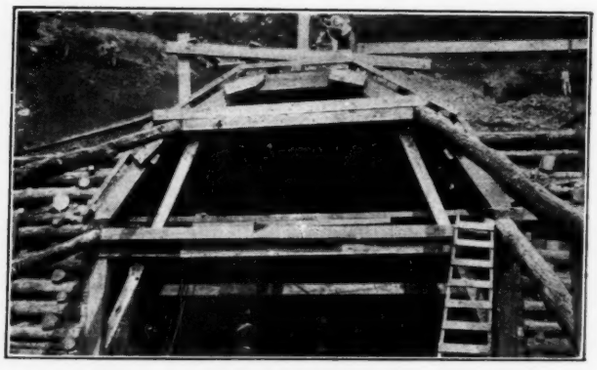
In making the excavation for the approaches on the west end, difficulty was encountered due to sliding of the hillside. This necessitated an excessive removal of dirt before the portal point was reached. In order to start timbering, the barrel was begun some 25 feet ahead of the portal, but even with this precaution the hill continued to move. The sliding continued in such amounts that the first arch would not hold, the plumb posts bellying inward and the top of the arch splitting upward. Braces, 12 inches in size, placed between the plumb posts, leaving only enough headroom for dump carts, failed. In addition to this motion inward toward the center line of the tunnel, the first ring of timbers started an outward motion and threatened to break away from the hillside. To prevent this motion the contractor used as braces 12 x 12-inch timbers 65 feet long, with footings on deadmen and inclined at a 30 degree angle with the horizontal. These retarded the movement but after completion of the first 4-foot section of concreting it was found that the ends had bitten into the plumb posts to a depth of about three inches.

The lack of weight on top of the arch and the heavy pressure exerted by the slide against the sides of the timbering, forced the arch upward. To counteract this, steel tie rods were used to hold the arch down, the lower ends being tied into the floor of the tunnel. The movement was so sharp that time to concrete the lower eyebolts of the ties was not available and they were leaded. The first set of ties retarded the action and a second pair succeeded in holding the ring to shape until concreting could be started. The first section of the concrete, 4 feet long, shows the remains of the 12 x 12 timbers in the side walls, where they were sawed off, and the buried portions of the tie rods were burned off flush with the arch walls.

Timbering is all 12 x 12, and is placed in the arch in five segments, each five feet long. In one



TUNNEL FORM STARTED IN THE APPROACH CUT BECAUSE OF EARTH SLIDES



CLOSE-UP OF PORTAL, SHOWING TRANSVERSE BRACING, AND TIES TO PREVENT ARCH LIFTING

short stretch the rock formation supports the side plates, but for the most part it is necessary to use plumb posts thruout.

The original plans called for rings on 4-foot centers, but this spacing would not hold, and after successively trying 3-foot, 2-foot and 1-foot spacing, the timbers are now jammed; in several sections they are even then supported by falsework. This heavy load is due to the proximity to the top of the hill.

In excavating, both rock and soil are encountered; the rock being limestone, with a tendency to slip inward, and the earth being clay. The tunnels pass through the top of the rock formation, and as far as tunneling is concerned, no overhead support is offered by the rock. A few feet of clay and then the cap of a rock stratum is unearthed.

An especial difficulty is due to the staggered excavation, it being necessary at times to shoot rock, with a ring supporting loose clay jammed against the face. To date only one ring has been shot away, and the unsupported roof held long enough to enable another placement before serious damage was done.

The contractors are side drifting thru the hill, 20 foot drifts giving placement for the side plates at bench level in all kinds of material. Where possible, rock support is used until ready to place the masonry, when plumb posts are dropped and the side walls drilled away.

OPEN CUT ABOUT COMPLETED. ONE PORTAL STARTED

The concrete lining is to have a thickness of 27 inches throughout. Wooden forms are placed in sections, the length depending on the character of the supporting wall, the natural material being used in all cases for one side of the form.

Timbering is removed as rapidly as possible, concreting following the bench at a distance of only

CONDITION OF ENTRANCE TO TUNNELS AFTER LAND SLIDE

Shows bracing against longitudinal motion, wire tension brace (in right hand tunnel) to prevent arch being forced up, and cribbing to hold slide

about 100 feet. The concrete mix is 1:2:4. A Koehring concrete mixer is located on the hillside and the concrete is chuted directly to the portal and carted to placement as the forms are made ready. It is dumped from buggies up to the beginning of the arch and placed with shovel in the arch. The key of the arch is concrete in 4-foot longitudinal sections and is shoveled. The concrete coarse aggregate is kept away from the face of the mass by spading with long-handled shovels, and the finished wall shows a smooth surface. Pneumatic concreting will not be used in this construction.

Because of the long rise before the portals are reached and the need for a wide roadway on the approaches, all spoil is being used for this road fill. In line with the usual tunnelling procedure, there is no classification of the material excavated, the contractor agreeing to remove both rock and dirt at the same unit price.

The timber is to be paid for as used and this item has already exceeded the estimates by more than 100 per cent, although only 35% of the tunnelling has been completed. The original estimate was 200,000 feet for the complete job.

Cleveland's Southerly Sewage Treatment Works

The high and low-level sewage, together with industrial wastes, from the southerly and southwesterly sections of the city of Cleveland, Ohio, discharge into the Cuyahoga river through a number of scattered sewer outlets. This contributes materially to the objectionable pollution of the river, which at times is carried far out into Lake Erie so that some of it reaches the water works intakes. To remedy this condition, the city has constructed what is known as the Southerly Sewage Treatment Works.

The purification requirements of these works, especially in the summer time, seem to be such as to demand the removal of 88% of the organic matter and 90% of the pathogenic bacteria. It was estimated that by 1940 the population to be served by this district would be about 400,000, of which 70% would be tributary to the sewer system. The present plant has therefore been constructed to serve a population of 280,000, with the layout so designed as to permit increasing the capacity to 1,250,000 persons.

The engineers considered two types of plants, the Imhoff-trickling filter, and the activated sludge. It was believed that the latter would necessitate a large operating expenditure and that the Imhoff tank-trickling filter plant would be less expensive in ultimate cost and would give as satisfactory results. The plant as designed comprises bar gratings, grit chambers, Imhoff tanks, dosing tanks, trickling filters, humus or secondary tanks, covered sludge drying beds, pumping station and appurtenant buildings. The outfall sewer has been used as a core wall for a dike, which is necessary along the westerly line of the site to protect the plant from inundation during floods.

Sewage enters the plant through a three-way channel and a long overflow weir is adjusted from time to time so as to divert sewerage into the plant at the rate of 400 gallons per capita, any excess flowing through a bypass outfall. Hydraulically operated gates divert the flow to each of combined gratings and grit chambers, or to a dry-weather flow channel in the center of the grit chamber layout.

The bar gratings are inclined, with a clear opening of 1½ inches. It is planned to rake these by hand at first, but space is provided for mechanical raking should its installation be deemed necessary at some future time. The grit chambers have been made shallow at the inlet and outlet ends and have two pockets or sumps which collect the grit. A monorail system with a clam shell bucket, electrically operated, is provided to travel directly over the sump and remove the grit to dump cars.

There are two sets of Imhoff tanks, 6 tanks in each set, with a central covered gallery between them. The tanks are 60 feet by 107 feet in plan, and have a water depth of about 25 feet. Just before entering them, the screened sewage passes through a venturi meter. From the Imhoff tanks the effluent is pumped into dosing tanks which distribute it onto the filters. These contain 10 feet depth of 2½-inch broken limestone, placed over an underdrain system of the Metropolitan type. There are six filters, each one acre in area, and designed to serve 40,000 persons. Provision is made for flooding each unit of the filter when desired in order to reduce the fly nuisance.

The secondary sedimentation or humus tanks, of which there are three, are about 80 feet square with conical shaped bottoms and are provided with Dorr sludge removal equipment. The solids from the bottom of the humus tanks are pumped into the lower compartments of the Imhoff tanks where they combine with the sludge. The sludge from the Imhoff tanks is drawn off occasionally into two main pipe lines located in the operating gallery between the Imhoff tanks and flows by gravity to ejector pots in one end of this gallery; which pots operate automatically with air pressure and deliver the wet sludge to drying beds.

There are 23 drying beds, each 226 feet by 18 feet, which are covered with glass construction of green house type. The dried sludge will be shovelled into dump cars and hauled by a gasoline engine to low land south of the canal for disposal.

Approximate estimates of the quantities involved are as follows: Excavation, 200,000 cubic yards; concrete 42,000 cubic yards; steel reinforcement, 2,000 tons; cast iron piping 900 tons; stone for trickling filters 97,000 cubic yards. Construction of the major portion of the work was started in June, 1926, by the Mellon-Stuart Company of Pittsburgh and it is believed that the work will be completed to such extent that sewage can pass through the plant some time early this year. The construction cost of the work when completed is roughly

estimated at $3,725,000, which represents a per capita cost of $13.25.

The work is being carried out under the general direction of W. S. Ferguson, director of public service, and Robert Hoffman, commissioner and chief engineer. George B. Gascoigne prepared the design and is supervising the construction of the work and will supervise the operation of it during the first two years of its service.

Utilizing Sewage Sludge Gas*

Experiment at Birmingham, England, with gas engine driven continuously for six years, and estimated possibility of deriving seventeen hundred horse power.

At the works of the Birmingham, Tame and Rea District Drainage Board 400,000 tons of crude sludge, containing 8 per cent of dry solid matter, are dealt with each year by the separate sludge digestion process. The crude sludge is pumped into tanks set apart for the purpose. At the Saltley works are situated the primary digestion tanks, in which the sludge is retained for three months. It is then pumped to the secondary digestion tanks at a works more than 4 miles away. The sludge is retained in these tanks for a further period of two months, after which it is pumped on to drying beds. At this stage it contains about 12 per cent of dry solid matter.

During the process of digestion about 25 to 33 per cent of the dry solid matter is converted into a gas composed of 67 per cent of methane, 30 per cent of carbon dioxide, and 3 per cent of nitrogen, having a calorific value of about 625 B.t.u. per cu. ft. Most of this gas is given off in the primary digestion tanks, of which the total capacity is 147,000 cu. yds. Hitherto it has all escaped to atmosphere.

In 1921 John D. Watson, M.Inst.C.E., constructed a plant at the Colehall works of the board, where a 34 h.p. gas engine driven by sludge gas has been in daily use ever since.

In 1925 the engineer to the board, H. C. Whitehead, Asso.M.Inst.C.E., had an exhaustive investigation made of this plant, to determine what amount of power might be expected from the much larger quantities of sludge available at the Saltley works. The quantity there from which gas might be collected economically was taken as 100,000 cu. yds. The results of this investigation are given in the table. Mr. Whitehead commenced by installing at the Saltley works a 150-h.p. vertical gas engine, a 100-kw. 4,000-volt alternator, and 144 floating gas collectors, each 20 ft. by 10 ft. The success of the scheme depended upon the design and construction of a cheap and efficient type of gas collector.

The problem of collecting gas from a sludge-digestion tank cannot be solved by roofing the tank completely, on account of serious difficulties enumerated in the paper. The principle of the floating type of collector of moderate dimensions was determined as the best to adopt, and experiments were carried out to observe the behaviour under practical conditions of the more suitable materials for construction. As a result of these experiments, it was decided to install a floating reinforced concrete gas collector for use with the first unit of the scheme, on account of low initial and maintenance costs, and efficiency in gas collection.

The form adopted for the design was that of a raft 20 ft. long by 10 ft. wide, bounded by vertical sides, extending 2 ft. above the raft and 2 ft. below, forming two open compartments, the lower for the collection of gas and the upper for providing the necessary displacement to float the mass. The gas is drawn off from a pyramid formed on the centre of the raft. The size of the collector is limited by its maximum permissible weight, which is about 8 tons in this case.

When finished, a collector is slung by chains clamped to long bolts embedded in the four corners, lifted off the core mould by an overhead crane, and carried horizontally for lowering in the sludge. The collector is raised and launched when only twenty-two hours old, the two sides then acting as beams 20 ft. between supports, and each sustaining a dead load of nearly 4 tons. An output of one collector per diem from two moulds only has been maintained. The collectors are coupled in three blocks of forty-eight each to give an estimated yield of 16,000,000 cu. ft. of gas per annum.

The plant was officially put into service on September 29, 1927, and has been running daily on full load since. The engine as supplied by the makers is quite standard, but certain adjustments have been made to suit the peculiarities of the gas.

Under the favorable conditions existing on the board's works, the estimated production cost of cur-

Gas Production by Primary Sludge Digestion Tanks at Birmingham, England

	Measurements at Colehall Plant 94 cubic yards of sludge		Estimated figures for Saltley Plant Sludge taken as 100,000 cu. yd.	
	A	B	A	B
Indicated h. p. hrs. per week	193	270	205,000	287,000
Indicated horsepower	1.15	1.61	1,220	1,710
Brake horsepower	....	....	915	1,280
Kilowatts	....	....	610	850
Cubic feet of gas (500 B.t.u.) per annum at 15 cu. ft. per i. h. p. hr.	....	....	160,000,000	224,000,000
Cubic feet of gas (625 B.t.u.) per annum	....	....	128,000,000	179,000,000
Value of gas (625 B.t.u.) at 36 cts. per 1,000 cu. ft. under collectors	....	....	$46,000	$64,000

A—Gas used intermittently, some leaking to atmosphere, average of 12 months' results.
B—Gas used continuously, allowing no opportunity for leakage, average of 1 month's results.

*Abstract of paper before Institution of Civil Engineers (Great Britain) by Frank Charles Vokes and Charles Bruce Townend.

rent is 0.49d. per unit, effecting a net saving of over £1,000 per annum for the first unit. The estimated cost of gas production on the basis of 16,000,000 cu. ft. per annum from this unit is 7½d. per 1,000 cu. ft. of gas with a calorific value of 625 B.t.u. per cu. ft.

An abundant and cheap supply of power will seriously influence, if not completely control, future developments in the purification of Birmingham sewage. The estimated total available output of 10,000,000 h.p.-hours per annum is about five times the board's present requirements.

Garbage Disposal in Cleveland

The city of Cleveland, Ohio, last year collected and disposed of 157,175 tons of garbage at a total cost of $1,036,177, which gives an average cost of $6.55 per ton. There has been a steady reduction in the average cost since 1921, when it was $11.69 with a total collection of 92,385 tons. Collection is by means of motor trucks and wagons, which haul the garbage to a central dispatch station with a direct rail connection to a reduction plant outside city limits which was constructed in 1925.

Arrangement has been made for the transportation of the garbage by rail from the central station to the reduction plant at a flat rate which gives quite a low cost per ton.

The cost per ton for collection and disposal decreased from $1,080,000 in 1921 to $937,000 in 1924, increasing to $1,036,000 in 1926. The cost per ton has steadily diminished, however, from $11.69 in 1921 to $10.87, $9.23, $7.99, $7.34 and $6.55 for the successive years respectively. The revenue was about $162,000 in 1921 and increased to $275,000 in 1923, fell to $199,000 in 1924, and increased to $315,000 in 1926.

Averaging the years 1921 to 1923 and the years 1924 to 1926, all inclusive. we have the average cost for the first three-year period as $10.63 per ton, and $7.29 per ton for the second period; while the revenues averaged $2.24 per ton during the former period and $1.91 per ton during the latter period.

William A. Stoller is superintendent of collection and C. C. Smith is engineer of garbage disposal.

Snow Handling in Yonkers

The method of handling snow employed by Yonkers, N. Y., was described by William Goldsmith, commissioner of public works of that city, in discusssing the subject before the American Society of Civil Engineers. He stated that a system was inaugurated in 1926 that produced remarkable results. The city was subdivided into ten districts and each district mapped and the route of a snow plow shown on it, indicating exactly the order in which streets were to be plowed and the direction in which the plow was to go, keeping in mind that access to the railroads, schools and the business sections were of the first importance. In order to make this plan practical, the man who did the mapping went out on the job with the driver of the snow plow and in this manner was able to determine whether any practical improvements could be made in the route.

It was found that the best results were produced by the use of a tractor with a V-shaped plow in front of it; and although the city covers about 22 square miles and has 130 miles of streets, a path was plowed over each street within 24 hours after a snow fall, the plow being sent out as soon as three inches of snow had fallen. This is a residential area and the sidewalks are not cleared of snow by the city, but immediately after the storm people use the center of the road where the plow has opened the way. In the business sections the snow is dumped in the sewers or carted away with snow loaders.

Some years ago Mr. Goldsmith experimented to determine how soon snow melted after being dumped into a sewer manhole and found that it was melted within two hundred feet or before it reached the next manhole. He stated that ice melted in this manner about as quickly as snow; but R. A. McGregor, discussing the same subject, stated that in New York ice as large as would go into a 22 inch manhole top and from 3 to 6 inches thick was frequently thrown into the sewer, having been formed from snow that had been on the ground two or three weeks; and that a piece of this ice striking some of the old sewers of Manhattan, which were built before 1870 and are in bad condition, would sometimes rip out a course of bricks, necessitating considerable expense for repairing the damage. Also, after the snow has been on the ground two or three weeks there is a mixture of everything imaginable combined with it and dumped into the sewers.

Snow Removal Cost in California

A summary of reports on snow removal from state highways in California for 1926-1927, shows that 299 miles of highways were cleared of snow. Of this, 251 miles were kept open, and 48 miles were open to traffic by snow removal methods. The cost of keeping open the 251 miles was $15,970, and of opening the 48 miles $6,180. The machinery employed on the work included one rotary plow, 8 straight blade plows, 14 trucks, 14 tractors, and 14 graders.

This information appeared in *"California Highways,"* and was contributed by A. W. Smith, assistant maintenance engineer of the State Highway Department.

Supervision of Connecticut Water Supplies

The State Department of Health of Connecticut under the laws of 1918 has "supervision over all matters concerning the purity of any source of water or ice supply used by any municipality, public institution, or water or ice company for obtaining water or ice." The manner in which it exercises these powers for maintaining supervision of supplies is outlined in the November, 1927, issue of its monthly bulletin.

From this we learn that there are 115 public supplies in Connecticut, of which 80 are entirely from surface sources, and seven partially from such

sources. The department, through its Bureau of Sanitary Engineering, periodically inspects all public water sheds, as far as possible each year or at least every two years, depending upon the personnel available. Pollution hazards or possibilities are searched out and investigated and reports of the inspections are forwarded to the water officials, who are asked to follow up the carrying out of any needed improvements, with the department cooperating whenever possible. Only occasional inspection is given to the water sheds of two or three supplies where slow sand filtration and long-time storage furnish a high degree of protection.

Fifty-eight chlorination plants, exclusive of duplicate equipment, are used by 39 of the public water supplies and it is estimated that 75 per cent of the population of the state is supplied with chlorinated water. All chlorination plants are inspected regularly, usually from two to six or more times a year, by an engineer of the department, and tests are made of chlorinated water to determine the efficiency of chlorination.

At present there are three large slow sand filter plants, those in Hartford, New Haven, and South Norwalk, and two or three smaller ones; rapid sand gravity filter plants are operated by four communities and pressure filters by three.

At regular intervals, ranging from one to three months, each public water supply in the state is sampled and analyzed by the Bureau of Laboratories of the Department, each separate source being so analyzed where a city secures its supply from two or more sources.

Cross connections between public supplies and auxiliary industrial supplies are prohibited, except that temporary double check valves of approved type are permitted where installed in water-tight pits with indicator gate valves, gauges, and drip cocks for testing. There are now 162 such double check valve installations in the state and these are at present being tested at intervals of about two months by a representative of the department, and any valves found leaking are immediately opened up for inspection and repair.

Relining Payson Park Reservoir*

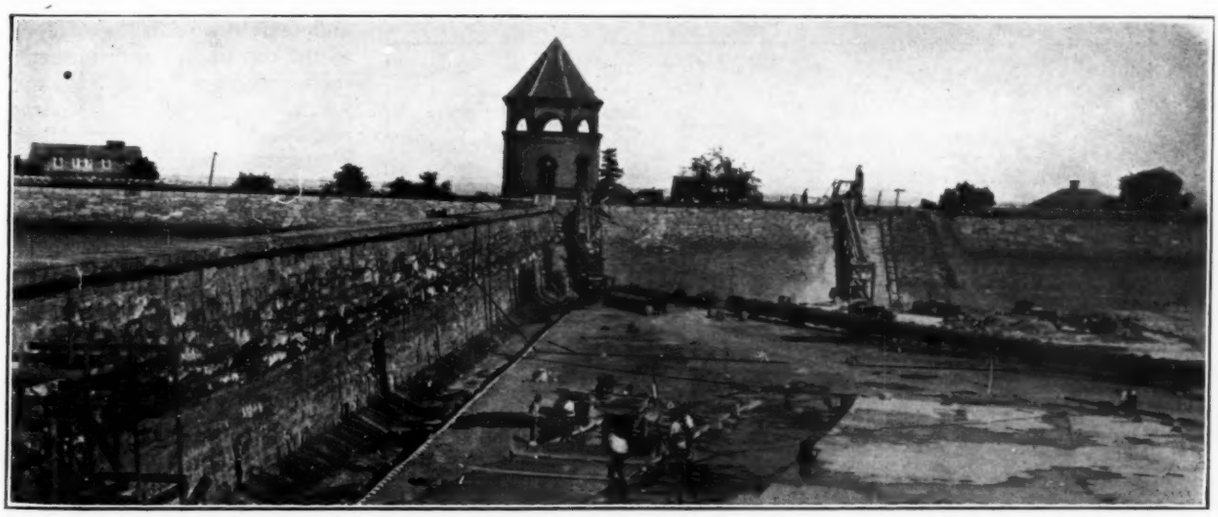
Leaking in reservoir remedied by applying two-inch layer of reinforced gunite. Method of attaching reinforcement to walls and of applying gunite, amount of materials used and other details described

Cambrdge, Mass., has a population estimated at about 125,000 and an average water consumption of about 12,000,000 gallons per day. Most of the water is obtained from Stony brook, is filtered, aerated and chlorinated, and is pumped to a distributing reservoir known as Payson Park reservoir, from which a 40-inch main supply line leads the water to the city. This reservoir was built in 1894 to 1896 and has a surface area of 7.4 acres and contains when full about 43,000,000 gallons.

*Abstract of a paper before the New England Water Works Association by L. M. Hastings, city engineer of cambridge.

The enclosing embankments are of earth obtained from the excavation. The floor was covered with cement concrete, and the inner-slopes with slope paving, the portion below the original surface of the ground being paved with brick on edge in Portland cement and the slopes above that being paved with split quarry granite block laid on a bed of cracked stone. The reservoir is divided into two equal parts or basins by a heavy partition wall of granite.

When an effort was made to fill the reservoir both basins leaked so badly that it was not possible to put more than 12 or 13 feet of water in them (the total



GENERAL VIEW OF SOUTH BASIN, CONCRETING FLOOR. IN BACKGROUND, RUNWAYS FOR BRINGING IN MATERIALS

REINFORCING WIRE MESH ON SLOPE

depth of water planned for was 20 feet) without starting an amount of leakage which flooded nearby cellars and caused protest from the owners of the property. Efforts to find just where the leakage occurred were unsuccessful and as it gradually increased until it averaged about 500,000 gallons a day, this, together with the increasing cost of the water due to the purification and the desire to keep the reservoir full in order to increase the fire protection afforded by it, led the water board to a decision to endeavor to make the reservoir tight.

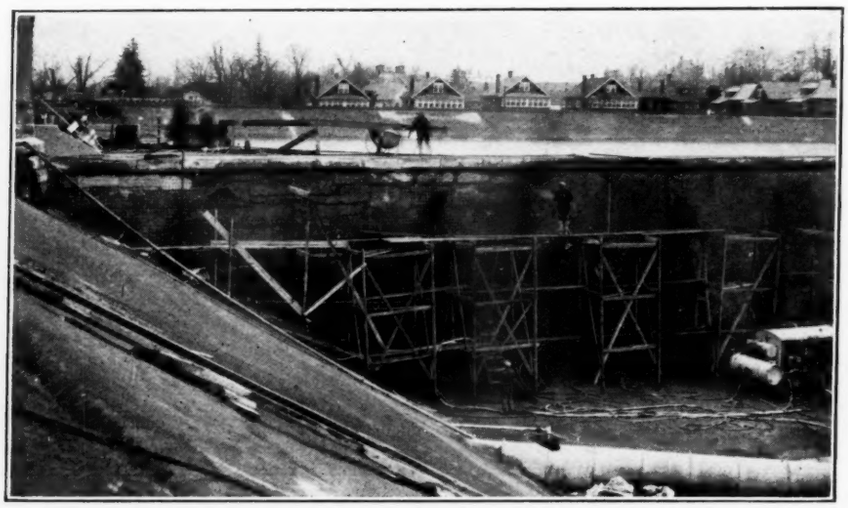
The matter was under consideration by the board for nearly ten years; various kinds and types of linings were proposed and considered and several visits were made to cities where similar work had been carried out; and the water board finally decided that the entire inner surface should be lined with not less than two inches of the best American Portland cement mortar applied in the form of reinforced gunite.

Bids for this work were asked for and a contract given for a lump sum of $131,576, but also unit prices were established as a basis for making monthly payments. These unit prices were as follows: Six-inch concrete floor at $2.25 per square yard or $13.50 per cubic yard. Two-inch gunite on the floor, $2.15 per square yard. Two inches or more of gunite on the slope, $2.45 per square yard. Two inches or more of gunite on the partition walls, $3.15 per square yard.

The contract called for a lining of gunite not less than 2 inches thick at any point and reinforced with wire mesh of galvanized number 5 steel wires spaced four inches apart in both directions, electrically welded and weighing about 71 pounds per hundred square feet. The floor of one basin was in very poor condition and was first covered with a concrete slab 6 inches thick, which was fairly true in surface, and the reinforcing mesh for the gunite was held in place on this by ⅜-inch anchor bolts placed 3 feet apart in both directions. The mesh on the brick paved slopes was anchored in the same way. On the granite paved slopes the surface was quite irregular, with many openings between the stone blocks of irregular shape. The anchors here were ⅜-inch galvanized iron lag screws inserted between the stones. The openings between the stones were filled or choked up with the gunite as it was shot onto the paving. The average thickness here was over the required 2 inches minimum. The sides of the partition walls were nearly vertical and had a rough quarry-face exposure. The ⅜-inch galvanized iron expansion bolts were inserted in holes drilled into the wall and the mesh hung from these. Here also the average thickness of the lining was more than 2 inches. In order that the mesh might be kept in the center of the gunite lining, the shooter's helper, with a stick having a bent iron in one end, lifted the mesh to the required height while the gunite was being shot in.

The gunite was specified to consist of one part Portland cement of any of six brands named, and 2½ parts of sand. The cement and sand were mixed dry in the proper proportions, then placed in the gun and the water added as required at the nozzle, where an air pressure of not less than 35 pounds per square inch was to be maintained. It was found very essential to keep this air pressure up, for if it were lowered the velocity of the jet was reduced and choking and irregular flow of the materials followed.

The mixing of the sand and cement was done by a mechanical mixer located outside of the reservoir and carried by a belt conveyor to the top of the embankment, there screened to break up the lumps and eliminate all coarse sand and other particles, then chuted to the bottom of the reservoir, where small auto trucks or buggies carried the mixture to guns placed on the floor, where the air pressure was raised to about 50 pounds. This forced the materials through lines of hose to the nozzles, where the nozzleman added the proper amount of water to the dry mixture and sprayed or shot the mixture with a circular motion onto the prepared surface. Usually four of these guns were operating at the same time.



SHOOTING ONTO PARTITION WALL

The spraying, or "shooting" as it is called, requires considerable skill and practice in order to produce good smooth work of an even thickness and without sand pockets, lumpy bunches, ridges, overlaps, or other defects.

At first it was found difficult to procure an even thickness on a smooth base. The temptation to run under the stipulated thickness was very great and was often difficult to detect. A very simple device proved useful in this case. It was simply a stick about 4 feet long in one end of which a prod or needle was inserted so as to project just 2 inches from the end of the stick. Any question of the depth of the gunite being applied was quickly settled by the inspector "needling" it before set had taken place.

The amount of "rebound" or loose material and coarse sand not attached in the shooting process was quite large, especially so on the vertical surfaces. In shooting the partition wall, it was estimated that 20 to 25 per cent. of the material was loosened and fell to the bottom as rebound. This material had to be carried out of the reservoir, transferred over the bank to the street level, and, although excellent stock, was given to the town for use as filling.

The sand used for the gunite gave excellent tests for cleaness and lack or iron or acid, and combined with cement in the usual proportions gave results better than the standard or Ottawa sand on 28-day tests when mixed in the usual 1:3 proportions. Tests for fineness showed that a somewhat less amount of finer grains were present in the sand than was found in some other sands; but while this might tend to make gunite less dense than some other sands with more fine grains and so increase the permeability, it was thought its other good qualities would outweigh those of the other sands offered for use.

It is expected that, even if the gunite does not show a high degree of impermeability at first, it in time may be decidedly improved by silting up of the voids in the gunite, especially in the bottom portions of the lining under consderable water pressure; while the upper portions of the lining will tend to be sealed with water growths, algae, etc., of a gelatinous nature, always found at shallow depths. The walls and slope paving of this reservoir were found thoroughly coated with growths of this nature at and for some distance below the water line, which were quite difficult to remove.

The total surface area covered by the gunite was 374,283 square feet, or 8.4 acres. It was found in this work that one barrel of cement was required to make sufficient gunite to cover 50 square feet of surface on the floors and brick slopes; on the dividing wall to make gunite to cover 38 square feet of surface, and on the stone slope paving to cover 34.8 square feet of surface.

Unit Prices on Highway Construction

The following are bids received during the past few months on highway work in the State of Washington:

Earth Excavation, including haul of 400 feet

Location	Amount cu. yds.	Successful Bid	Av. next 3 Bidders
Whitman County	17,970	$0.22	$0.24
State Road No. 1	6,370	.45	.43
State Road No. 2	23,930	.47	.50
State Road No. 5	12,800*	.50	.85†
State Road No. 9	188,410	.50	.72

*Haul of 500 feet. †Average next two bidders.

Overhaul on Excavation
(per 100 feet)

State Road No. 1	4,050	.04	.04
State Road No. 2	44,090	.03	.03
State Road No. 9	119,290	.04	.04

Rock Excavation

Whitman County	1,160*	1.45	1.27
State Road No. 2	100*	1.25	1.25
State Road No. 2	530†	1.00	.68

*Solid rock. †Loose rock.

Haul on Binder for Crushed Rock Roads
(Per cu. yd.—mile)

State Road No. 11	13,220	.18	.22

Class "B" Concrete in Place
(Per cubic yard)

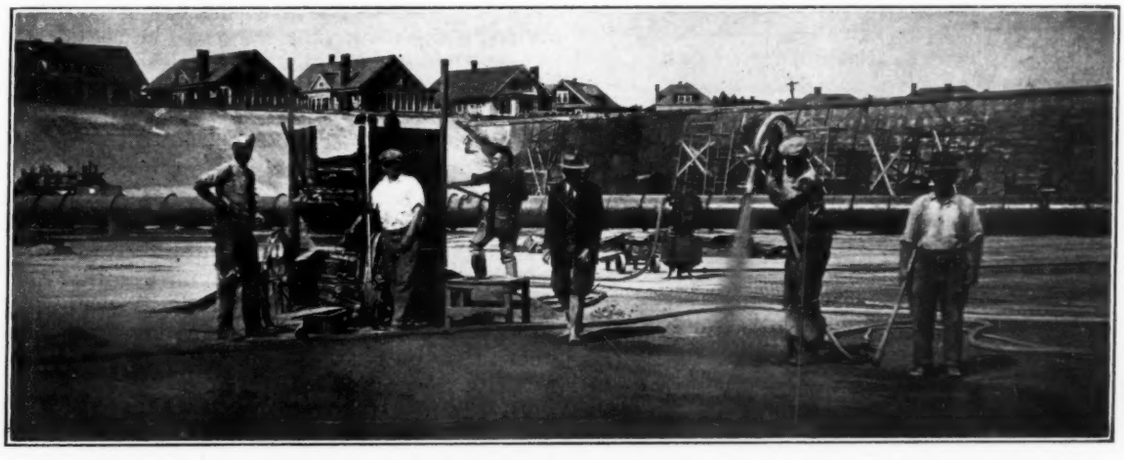
State Road No. 1	60	25.00	22.50
State Road No. 2	271.6	26.00	30.51
State Road No. 9	1943.7	45.00	41.33

Cement Concrete Pavement in Place
(Square yards)

State Road No. 1	32,694	1.94	1.99
State Road No. 2	83,470	1.89	1.903

Tandem Maintenance of Roads

In our January issue we described the tandem maintenance method employed on the roads of one New Mexico county. A recent issue of the "New Mexico Highway Journal" states that in December it was in use on all roads in nine counties of that state, and that before next summer it will be in use all over the state.



SHOOTING ONTO THE FLOOR. PARTITION WALL AT RIGHT: SLOPE AT LEFT BACKGROUND

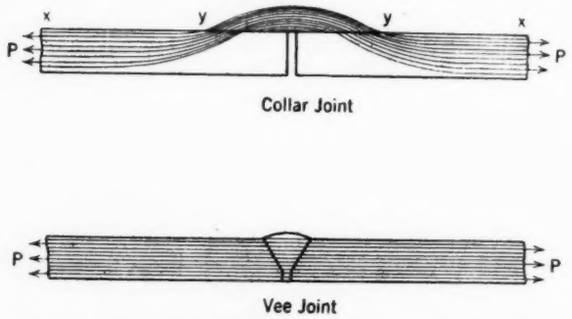
Cotton Reinforcement for Roads

A test of a cotton fabric as a reinforcement in an asphalt wearing surface to prevent the formation of "duck nests" or "washboard" effect is said to have shown promising results in South Carolina. A section of State Highway No. 2, a top-soil road, was scarified, smoothed and rebonded under traffic; a prime coat of light tar, 8 to 13 viscosity, was applied, and when partially set there was spread over it a cotton fabric with a yarn count of 7x7 in both warp and filling and weighing 7 ounces per yard; and on this was applied hot asphalt of 150 to 200 penetration, which was covered with sand. After nearly a year of use the surface is said to show little tendency to creep or form rugosities.

Welding Cast Iron Pipe

Investigations of the best method for laying bronze-welded cast iron pipe with the collar-type joint were concluded in 1927. During the investigation it was learned by the engineers of the Linde Air Products Company and the U. S. Cast Iron Pipe & Foundry Company, which jointly conducted the investigation, that the collar type of joint had certain defects. Three types of joints were investigated, the vee, collar, and combined vee and collar. The collar design takes advantage of the well known high shear strength of bronze adhering to cast iron. However, the investigation seemed to indicate that the collar type joint for a pipe was not as strong as it was thought to be and cross bending tests were made on full sized 12-foot sections. These showed that the bronze collar joint is only about 55% as strong as the pipe itself when De Lavaud pipe is used and only 42% as strong when sand-cast pipe is used. In all cases, failure occurred in the cast iron at the edge of the collar.

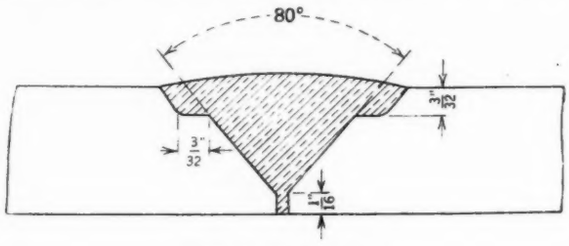
Investigations showed that the bronze welding produced no change in the chemical properties or physical structure of cast iron adjacent to the bronze welding, but that the failure was due to a concentration of stresses in the cast iron next to the bronze collar. For any metal under strain, stress distribu-



FLOW LINES IN COLLAR JOINT AND VEE JOINT

tion may be represented by lines of stress or "flow lines." In the illustration, these lines are shown for a collar joint. This shows a very decided stress concentration in the cast iron next to the joint at Y. The stress at this point may be two or three times that in the pipe further away from the joint. It was apparent therefore why the pipe should break at this point. A sketch of the vee type joint shows how the stresses are carried uniformly through the joint.

Early experiment had seemed to indicate that the vee type joint was weaker than the collar type but it is now known that failure was due to the fact that when cast iron pipe is machined, the machined surface is extremely difficult to tin and there is very poor adhesion of the bronze to the surface, due apparently to the graphite flakes that are exposed. This machined surface is easily decarbonized by annealing to a bright red, after which the tinning operation becomes practically automatic. Tests made with the joints so prepared showed that the strength



SHEAR-VEE JOINT

had increased to 79 to 83% of that of plain pipe, which is more efficient than any known mechanical joint.

In order to utilize the high shear adhesion of bronze to cast iron, a combined vee and collar joint or "shear-vee" type of joint was developed which gives practically the full strength of the pipe. Tests made with Class 150 De Lavaud pipe showed a breaking strength at shear-vee joints of 27,800 pounds per square inch in one case and 24,500 pounds in another case. It has been found that the most economical design is obtained by using a 40° bevel with the additional shear area about 3/32 inch from the outside of the pipe wall. Little or no thickening or reinforcement is required, since the bronze has an ultimate strength greater than the pipe itself. The annealing should be done at the pipe manufacturer's plant and not with a blow pipe in the field, as it may easily be improperly done.

In addition to its greater strength, this joint has other advantages. From a welding standpoint, if properly prepared, it is easier to make. The cost of the joint, including machining the pipe ends correctly, is slightly less than that of the collar type, but more expensive than the ordinary vee type.

Arlington's Municipal Power Plant

The village of Arlington, Ohio, in 1923 had a population of about 800 inhabitants and owned its own power plant. This consisted of an old 75 h. p. gas engine belted to a 75 k. w., 1100 volt, single phase alternator, with a belted exciter, which was operated only from dark until 11 P. M. each day. The fuel for this engine was obtained from a gas well owned by the village and located near the power house. The average gross monthly revenue totaled $270.60. That year the village purchased a Diesel 50 h. p. generating unit from the Fairbanks-Morse Company on terms which enabled it to pay for the unit out of the revenue. This unit supplied all of the

power with the exception of a period between seven and ten in the evening when the peak load was thrown on the old gas engine unit, which secured enough gas from the gas well to operate during this period. Occasionally the gas engine was out of commission and the Diesel engine carried the entire load.

Three years later the load had increased considerably, the gas engine was about ready for the junk pile and the gas supply was nearly exhausted. The village then purchased a 120 h. p. Diesel generating set and changed the system over to 2200 volts, three phase, 60 cycles. The load continued to increase and as a large quarry near Arlington desired to purchase all of its power from the village, the officials purchased a 180 h. p. Diesel generating set in the spring of 1927 and disposed of the old gas engine unit.

By the spring of 1927 the average monthly revenue had increased to $937.65 per month; the village had paid for the first unit and had been able to install and meet its obligations on the second unit, and had a paying up-to-date power plant consisting of a 50 h. p. F. M. Style V, generating unit, a 120 h. p. F. M. Style VA generating unit, and a 180 h. p. F. M. Style VA generating unit. The superintendent of the plant, A. J. Cluff, was largely responsible for the decision to enlarge the plant and for the choice of equipment. As an answer to the arguments of opponents to the new equipment that it would cost $500 a month for engineers' salary, Mr Cluff agreed to operate the plant and pay his engineer for a flat sum of $250 a month, which he has done up to date. He states that according to his records the fuel and lubricating oil cost of producing power at the present time is 0.68 cent per k.w.h. Also that up to date the total cost of repair parts on the first Diesel unit has been only $18.03.

The rates are arranged according to three schedules. Number 1, for consumers taking current off of the lighting circuit for lighting and motors not exceeding 5 horse power, from 12c to 4c per k.w.h. Schedule number 2, for consumers taking their current from the lighting circuit, for intermittent special work, from 12c per k.w.h. to 6c. Schedule number 3, for installations of commercial, private or public character where a consumer is connected to what is known as power lines, from 6c to 1¾c per k.w.h., the latter for all over 1500 k.w.h. per month. There is also a special cooking rate of 4c per k.w.h. for electric ranges.

Standard Symbols for Hydraulics

Standard recommended by sub-committee of American Engineering Standards Committee, representing six national societies and two Federal departments

At a general conference called by the American Engineering Standards Committee on the recommendation of the American Institute of Electrical Engineers, the Association of Edison Illuminating Companies and the American Society of Mechanical Engineers, it was decided February 13, 1923, to undertake the standardization of scientific and engineering symbols and abbreviations as a national enterprise. Later the American Society of Civil Engineers was added as a joint sponsor. The committee now contains representatives of thirty-seven national organizations. Of the nine sub-committees organized, one was assigned the subject of "Symbols for Hydraulics," this committee having been organized on May 3, 1926, with G. E. Russell, professor of theoretical hydraulics, Massachusetts Institute of Technology, as chairman and representative of the American Society of Civil Engineers.

The secretary of this committee is Gordon M. Fair, representing the Society for the Promotion of Engineering Education. The other members are:

Charles M. Allen, The American Society of Mechanical Engineers; H. K. Barrows; C. A. Bissell, Department of Interior; R. L. Daugherty, Society for the Promotion of Engineering Education; R. W. Davenport, Federal Power Commission; W. S. Franklin, American Physical Society; N. C. Grover, Department of Interior; F. L. Hunt, National Electric Light Association; A. L. McHugh, Hydraulic Society; Lewis F. Moody, The American Society of Mechanical Engineers; and R. S. Weston, American Water Works Association.

This committee has prepared the following standard, which is being distributed in tentative form for criticism and comment:

Symbols for Hydraulics

Acceleration

a = in general
g = due to gravity
A (or a) = Area

Channel Flow

A = area of section
V = average velocity in section
d = depth of flow
R = hydraulic radius
S = hydraulic slope
L = length
B = surface width
n = Kutter's coefficient of roughness
m = Bazin's coefficfent of roughness
C = Chezy's coefficient

Coefficients

c_v = of velocity
c_c = of contraction
c_a = of discharge
n = of roughness, Kutter's
m = of roughness, Bazin's
C = of Chezy
w or γ (*Gamma*) = Density (see Symbols for Turbines and Pumps)
D = Diameter
P = Energy per unit time (Power)
f = Friction-factor used in expressing pipe-loss

Head

h or H = in general
z = elevation head
h_p = pressure head
h_v = velocity head
$*h$ = lost head
R = Hydraulic radius
S = Hydraulic slope

Pressure

p = intensity of
F = total pressure (Force)

Pipes

V = average velocity in section
D = diameter of
$*h$ = head lost in
R = hydraulic radius
S = hydraulic slope
L = length
P = Power (energy per unit time)

*Note: With appropriate subscript.

Properties of water

w or γ (*Gamma*) = density (see Symbols for Turbines and Pumps)
K = modulus of elasticity
Q = Rate of discharge or flow
S = Slope, hydraulic
t = Time

Velocity

V or c = absolute (see Symbols for Turbines and Pumps)
v or w = relative to moving casing (see Symbols for Turbines and Pumps)
u = of moving casing
μ (*Mu*) = absolute
ν (*Nu*) = kinematic (kinematic viscosity = absolute viscosity ÷ density)

Weight

w or γ (*Gamma*) = per unit volume (density) (see Symbols for Turbines and Pumps)
W = per unit time

Weirs

H or h = head as measured
h_0 = velocity head of approach
Z = crest height
B = crest length
v_0 = velocity of approach

List of Symbols Specially Related to Hydraulic Turbines and Pumps

(Arranged by letters only)

(a) Symbols relating to Dimensions

B = axial breadth or depth of runner-entrance
D = diameter of runner or impeller
D_1 = diameter of runner or impeller vanes at the middle of the entrance space
D_{th} = diameter of runner or impeller throat (inside diameter or band or shroud ring)
r = radius to any point
a (*Alpha*) = angle between the directions of absolute, water velocity and runner velocity at any point, measured in degrees
β (*Beta*) = angle between relative velocity of the water and the runner velocity at any point, measured in degrees

(b) Symbols relating to Efficiency

e_h = hydraulic efficiency
e_m = mechanical efficiency
e = total or overall efficiency

(c) Symbols relating to Head

H = total head at any point ($H = h_v + h_p + z$)
h_p = pressure head at any point
h_v = velocity head at any point
z = potential head at any point

(d) Symbols relating to Power

P = power or energy per unit time
P_1 = power of turbine under 1-foot head
P_b = power at brake
P_w = power from water
Note: Where power is to be expressed in horsepower or other units, statement to that effect should be made in the context

n = revolutions per minute
n_1 = revolutions per minute under 1-foot head
n_s = specific speed or type characteristic as given by

$$n_s = \frac{n\sqrt{P}}{H^{5/4}}$$

Definition: Revolutions per minute under 1-foot head attained by a turbine of one horsepower capacity, or

$$n_s = n_1\sqrt{P_1}$$

ϕ (*Phi*) = ratio of peripheral speed of runner to $\sqrt{2gH}$

$$\phi = \frac{n_1}{\sqrt{2gH}}$$

u = circumferential velocity at a point on a rotating runner or impeller
V or c = absolute velocity of the water at any point in a rotating runner or impeller
Note: V is recommended for American practice and urged for international adoption. c is recognized as present international usage
V_m or c_m = meridianal component of the absolute velocity of the water (component in a plane containing the axis of rotation of the runner or impeller)
V_u or c_u = circumferential or tangential component of the absolute velocity of the water
v or w = relative velocity of the water with respect to the moving runner or impeller
Note: The hydraulic committee was divided in its opinion as to which letter would best serve the purpose. Small w is largely favored by turbine and pump designers as it conforms to the German and French practice. It has the disadvantage of being confused with the symbol for density unless foreign practice be further followed by adopting γ (Gamma) for density. The small v is favored by those in general hydraulic practice and by those in the teaching profession. Under the circumstances, the committee recommends v and w as alternates, γ being used for density whenever w is used for relative velocity.

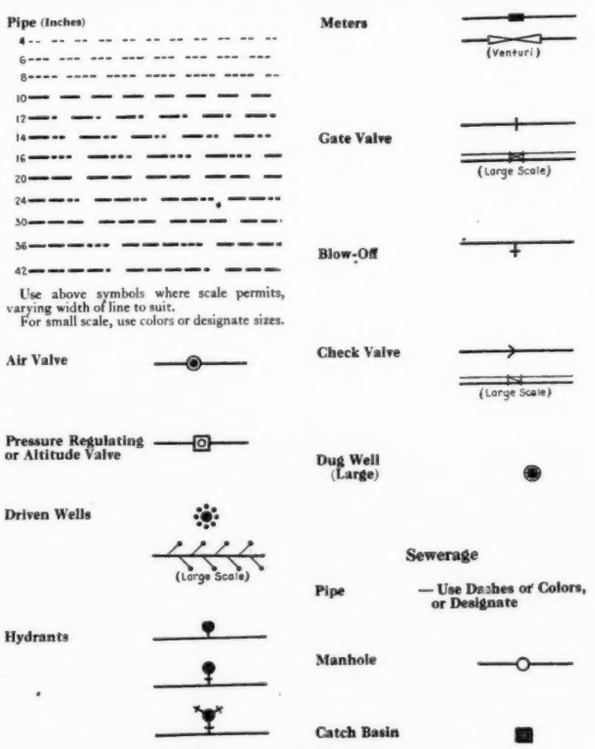
Note: **Subscripts 1 and 2 may be used** to refer to the points of entrance and discharge in either a runner or impeller, the assumption being that the water always flows from point (1) to point (2)

Thus V_1 and V_2 refer to the absolute velocity of the water at entrance and exit from a runner or impeller

Subscript u is to be used to denote velocity component in the tangential direction. Subscript m is to be used to denote velocity component in a meridianal direction. Subscript r is to be used to denote the velocity component in a radial direction

Thus V_u, V_m, and V_r denote components of the absolute velocity in the three named directions.

ω (*Omega*) = angular velocity, measured in radians per second



WATER WORKS SYMBOLS USED IN PUBLIC HEALTH ENGINEERING

Constructing New Mexico Gravel Road

Continuous stretch of ninety-two miles of gravel and crushed stone surfacing. Equipment used in crushing and hauling material. Difficulties in constructing forty-three bridges

By F. D. Hawley *

A recently completed highway between Gallup and Shiprock, New Mexico, over the Navajo Indian Reservation gives the farmers of the fertile San Juan Valley an opportunity to take their products to Gallup, which is a good distributing point being on the direct route of the Atchison, Topeka & Sante Fe railroad. The highway also gives access to the Mesa Verde National Park and to the oil stations on the reservation and in the San Juan Valley. This portion of the Federal Aid Road system is one of the longest continuously improved stretches in the state of New Mexico, being 96 miles long with no right angle turns in the entire length. The route was formerly a seemingly endless stretch of desert where the only habitations were the Indian school at Tohatchi about 25 miles from Gallup, three Indian trading posts, and an occasional lonely Indian hogan and oil camp.

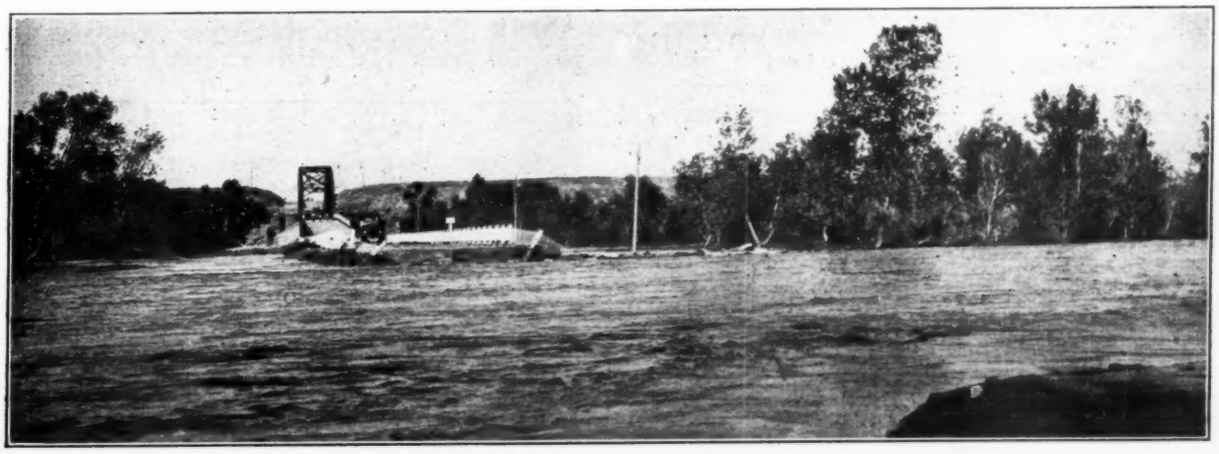
Except for 3.4 miles of concrete paving between Gallup and Gamerco, the entire road was built with gravel or crushed stone surfacing. This concrete pavement and the grading and structures between Gallup and the Navajo Indian Reservation line was awarded in one contract to A. O. Peabody in 1925 and was the only one which the state aided in paying for, the Federal government standing the entire expense of the balance of the road, 86 miles and costing $1,045,000, except for the cost of the reconnaisance and preliminary surveys, which was less than $6,000. The state of New Mexico, through its Maintenance Department, is at present surfacing the highway between the end of the concrete pavement and the reservation line.

The balance of the road, from the Navajo Reservation line to Shiprock, was awarded in nine contracts; two of them, totaling 14 miles, to W. E. Clarke Construction Company; two, totalling 18.6 miles, to George W. Orr; one of 10.36 miles, to the Mountain States Contracting Company; two, totalling 20.34 miles, to Tobin & Maloney; and two, totalling 19.2 miles, to C. E. Mitcham. A contract for the 43 bridges on the project was awarded to the Salle Construction Company. These are of creosoted timber and cost approximately $200,000.

The method of road construction on all the projects was the same. After the road had been rough-graded, 3½ inches of the grade was trenched out, leaving the surface dirt on each side of the road for finishing the shoulders. Forms were then placed eight feet from each side of the center line and the fine grading was completed by hand. The average cost of preparing the rough sub-grade, distributed over the total cubic yardage of gravel surfacing, was approximately 1c. per cubic yard, placing forms ½c., fine grading 6c. and spreading the surfacing about 2½c. The excavated material was moved for about 15c. per cubic yard within the limit of free haul. When overhaul was necessary, several of the contractors discontinued the use of teams and fresnos in grading and used a 60-ton "Caterpillar"-Russell elevating grader and dump wagons to move this overhaul material. This method of handling the overhaul proved very economical and increased the progress of the work materally.

Gravel was used for surfacing on all the contracts except those of C. E. Mitcham, on which crushed stone was used as the best surfacing material available. A considerable part of the gravel, however, was oversized and all of it was run through crushers

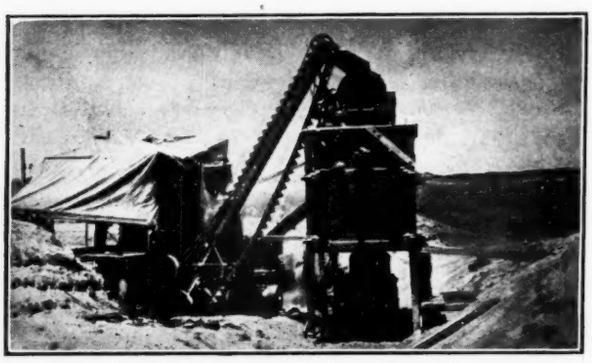
* Project Engineer, New Mexico State Highway Department.



EAST APPROACH TO SAN JUAN BRIDGE, JUST COMPLETED, WASHED OUT BY FLOOD JUNE, 1927

ELEVATING GRADER FOR LONG HAULS

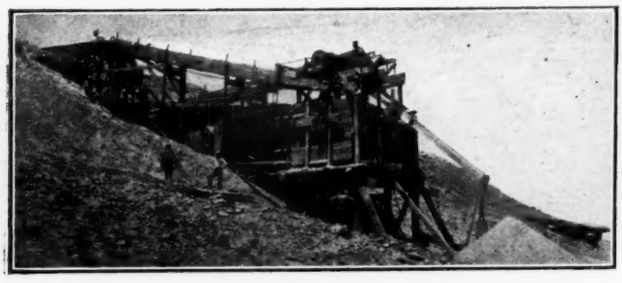
before being hauled to the road. The Mountain States Contracting Company used a Cedar Rapids one-unit crushing plant with a "Caterpillar" 60 for power. George W. Orr used a Telsmith crushing outfit (1 breaker and two reduction crushers), with Waukesha stationary motor for power. Tobin & Maloney used a Simons gyratory outfit, one Climax motor and two Fordson tractors for power. C. E. Mitcham used a Cedar Rapids one unit plant with one breaker, the power consisting of a steam



TELSMITH CRUSHING PLANT

tractor and a Waukesha stationary motor. The Telsmith plant seemed to be the most economical and efficient as it was the best fitted for the class of material used. The output of each plant averaged approximately 350 cubic yards per day and the average cost for crushing the material was about 90c. per cubic yard delivered to the bins.

Various types of trucks were used to haul the crushed material to the road, one contractor using Ford and Chevrolet trucks with trailers having a capacity of 2½ to 3 cubic yards, another using White trucks with a capacity of 3 to 5 cubic yards,



SIMONS GYRATORY CRUSHING OUTFIT

A SECTION OF FINISHED ROAD, NOVEMBER 7TH

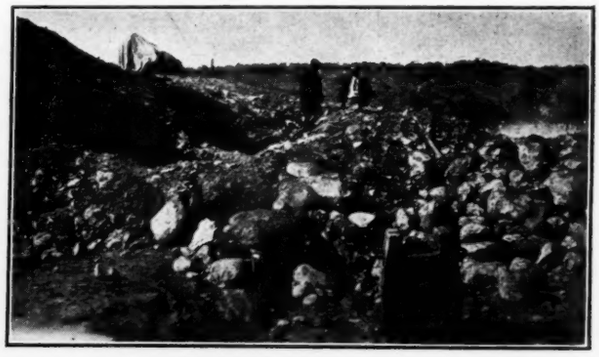
another Mack and International trucks with a capacity of 3 to 5 cubic yards, and one using Ford and Chevrolet trucks without trailers with a capacity of 1 to 1½ cubic yards. During the rainy weather the lighter trucks proved more satisfactory than the larger ones, but on the whole the progress of hauling averaged about the same with all kinds. The average cost of haul from the crusher to the road was 28c. per yard mile.

The trucks hauling the material were allowed to use the new road and thus the material was compacted as it was placed, being bladed and dragged twice each day during the construction. This eliminated the use of a roller. The gravel surfacing material was spread by hand to true form and grade with a depth of 8 inches loose measure, allowing for a compaction of approximately two inches.

A FIFTY-FOOT STEEL SPAN BRIDGE

Progress on all the contracts was very satisfactory but during the rainy season (and on the desert the "rainy season" means cloudbursts), several washouts occurred during construction, which caused much additional work in constructing protection ditches and dykes to keep the water from damaging the new highway.

Much difficulty was experienced in driving the piles for the 43 pile bridges. Large boulders were



PILES COULD NOT BE DRIVEN BECAUSE OF BOULDERS, SO PLACED IN EXCAVATION ON CONCRETE SILLS

TYPICAL CREOSOTED BRIDGE

encountered which in many instances necessitated excavating by hand and placing each separate pile in concrete. All bridge timbers were received framed and ready to place without additional fitting, with very few exceptions. They were shipped to Gallup and hauled from Gallup to the various projects, giving an average haul of 45 miles at a cost of 20c. per ton mile. To secure coarse and fine aggregate for concrete work used in connection with the bridges which would meet the requirements of the Bureau of Public Roads, an average haul of ten miles was necessary, costing the contractor approximately $3.00 per cubic yard at the bridge site. The cement was hauled from Gallup at an approximate cost of $4.25 per barrel.

These bridges were originally planned to be adequate to take care of general flood conditions, but in some cases the spans were not sufficiently long to prevent back-scouring against the bulkheads and the waters washed away the approaches entirely in some cases, and it was found necessary to add additional spans to several of the bridges. In extreme cases a rubble masonry wall was built in front of and tied to each bulkhead, this wall being 6 feet wide at the bottom and 2 feet at the top, carried three feet below the ground level, and the top coming to within 7 feet of the decking. This masonry cost $12.50 per cubic yard in place.

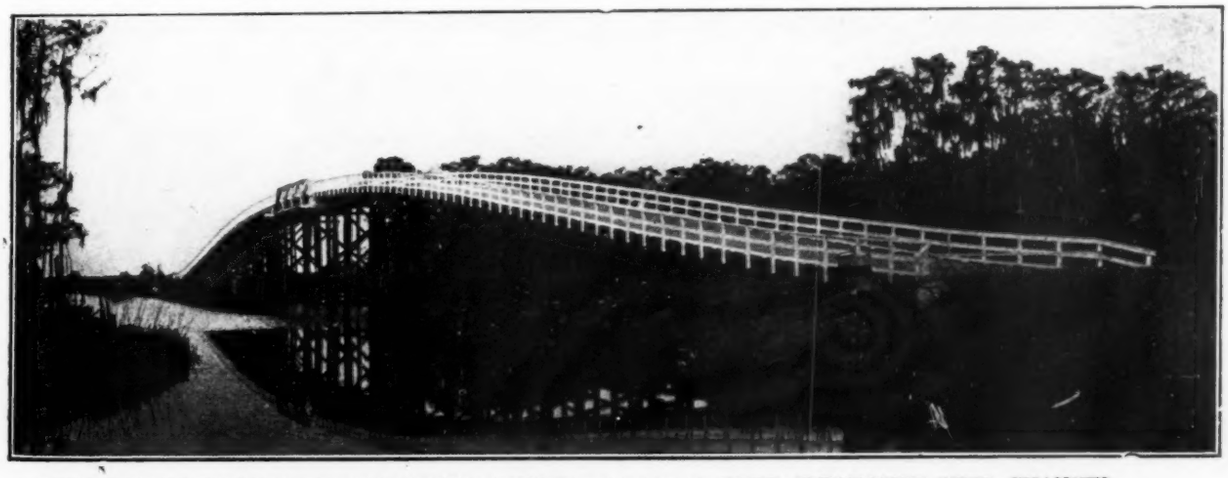
A Graceful Pile Bridge

In building State Project No. 512-B, a bridge across Bayou Lacassinne, on the main highway between Lake Charles and Lake Arthur, the state of Louisiana was confronted with the necessity of crossing the bayou at a sufficient elevation to give height of 25 feet above high water under the channel span, as required by the U. S. War Department for navigable bodies of water, or else to locate a draw span at this point with the accompanying expense for a bridge tender. Although the general elevation of the ground surface at this location is only a few feet above average low water level, and therefore a rise of nearly 25 feet in the road would be necessary to cross the channel span, the former alternative was adopted.

The bridge consists of a 70-foot steel girder span and two timber approaches each 327 feet long. The center span is supported on two piers, each consisting of ten creosoted pine piles driven in two parallel five-pile bents two feet apart. These piles are grouped in pairs and are firmly held in place by a double system of bracing with 3 x 10-inch plank; also six lines of horizontal braces extend from low water elevation to a point six feet above low water level. These piles are cross-capped with 10″ x 12″ x 3′ timbers, upon which is placed a grillage of 10″ x 12″ x 25′ timbers and on this two caps, 12″ x 12″ x 22′, one upon the other, to form a foundation for the stringers of the timber approaches. The center span rests directly upon the grillage timbers. Each approach consists of thirteen 25′ spans supported on 4-pile bents, on each of which is a 10″ x 12″ x 22′ cap. Eleven lines of 6″ x 16″ x 26′ stringers support 3″ flooring 10″ wide. Instead of the usual uniform rising grades from the ground elevation to that of the fixed span, the engineer designed the approaches in the form of a parabolic curve, which gives a very graceful effect.

The construction of the bridge required approximately 82,600 feet board measure of creosoted timber and 7,000 lineal feet of creosoted piling; both treated under pressure with a final retention of 12 pounds of creosote per cubic foot, in accordance with the standard specifications of the Louisiana State Highway Commission, as also of the American Wood Preservers Association. Rails, posts and hand rails were not treated but were painted with two coats of white lead.

This bridge was designed and constructed under the supervision of N. E. Lant, bridge engineer of the Louisiana State Highway Department, and the contractor was J. A. Hanchey of Mittie, Louisiana.



PILE BRIDGE RISING WITH PARABOLIC CURVE TO GIVE 25 FEET CLEARANCE OVER CHANNEL.

Low-Cost Improved Roads

Report of an investigation made by the Highway Research Board. Order of preference of different types by users. Materials used; methods and costs of construction and maintenance; selection of type and of cross-section.

At the meeting last December of the Highway Research Board a report was presented by C. N. Conner giving the result of an investigation of the low cost road situation.

"The successful low-cost surface," said he, "is a light-traffic road, carrying less than 1500 vehicles per day as a maximum with an average of 600 or less. This may be mixed traffic with a fair percentage of light trucks and an occasional heavy truck. Low-cost roads of this type will adequately meet the needs of a large area of the country for many years to come, provided intelligent maintenance methods are perpetuated."

The points of interest were found to be: first cost; maintenance cost; and traffic and service. "Other points included conditions of climate, salvage, soil and subgrade, construction and maintenance methods, typical cross sections and topography.

"Preference for types to be investigated was affected somewhat by the local conditions surrounding the persons questioned but the majority favored the following order of importance:

1. Bituminous surface treatments of gravel, stone, slag and miscellaneous materials.
2. Bituminous macadam and various types of bituminous concrete.
3. Untreated surfaces of traffic-bound stone or gravel, water-bound macadam, earth and sand-clay.
4. Non-bituminous surface treatments of gravel, earth and sand-clay."

While it was felt that all of these types and the factors affecting them should be considered, this survey was confined to those types which are considered serviceable investments by those responsible for their existence. Facts were obtained through field observations, conferences, and published information. Valuable assistance and cooperation were given by the Bureau of Public Roads, Weather Bureau, Forest Service, Patent Office and practically all of the State highway departments and several counties. Comments and suggestions were requested and received from representatives of the asphalt, tar, Portland cement, calcium chloride, lime, rock asphalt, crushed stone, sand and gravel, and machinery and equipment industries. Contributions to the cost of the investigation were received from T. Coleman Dupont and the American Road Builders Assn. while the Asphalt Association and the American Tar Products Company are contributing to the cost of printing the report.

The survey was limited in general to untreated surfaces which cost less than $10,000 per mile and to surface treatments and surface courses which cost less than $6,000 per mile. The types included in the survey were, under the head of Untreated Surfaces: sand-clay; disintegrated granite and shale; gravel in general; top dressing or traffic-bound surfaces of gravel, slag and stone; macadam; line rock, caliche and marl; and miscellaneous surfaces of volcanic cinders, mine tailings, and industrial wastes. Under the head of Surface Treatments and Surface Courses there were considered bituminous and non-bituminous dust layers; skin surface treatment; surface treatment with prime and seal coats; mixed in place bituminous surface—fine aggregate type; mixed in place bituminous surface—coarse aggregate type; premixed, laid cold, bituminous surface course; natural rock asphalt; modified or puddle bituminous macadam, cold application; bituminous macadam, hot application; hot mix surface courses; and miscellaneous base or surface of local materials and non-bituminous admixtures.

The total report contains about 60,000 words, photographs, cuts of cross-sections and tabulated data. However, only a brief digest of the principal factors which affect this very broad subject were presented at the meeting. This was divided under the various headings of "materials," "methods and equipment for construction and maintenance," "cost of construction and maintenance," "selection of type and cross-section," "service," and a practical application of the results of the survey.

MATERIALS FOR UNTREATED SURFACES

The predominating surface materials are gravel, sand-clay, hard and soft stone, slag and lime rock. There are also miscellaneous materials such as shell, volcanic cinders and stone screenings.

Sand-clays are used principally in the southern states. According to Dr. Strahan, suitable sand-clays should contain clay from 12% to 18%, silt 5% to 15%, total sand 65% to 80%, and sand above No. 60 sieve 45% to 60%.

Gravels of various quality and gradation are used in nearly every state. Nearly all specifications require that gravel shall be hard and durable; that it shall all pass the 1½-inch. screen, or better still through the 1-inch screen. California requires all gravel to be crushed. Clay in gravel as a binder is used sparingly.

Lime rock, marl, caliche and similar materials make excellent bases, but poor wearing surfaces. Because they are soft and crush during construction, large sizes up to 3½ inches are permitted.

Crushed stone or crushed slag of a durable character are being used for surfacing in much the same manner as gravel construction in sizes through the 1½-inch and 1-inch screen, and smaller. Stone for water-bound macadam or broken stone base is specified in larger sizes.

MATERIALS FOR SURFACE TREATMENTS AND SURFACE COURSES

The principal binders or admixtures are asphalts, tars, calcium chloride, lime and Portland cement.

The principal aggregates are gravel, sand, stone or slag and sand-clay.

In the asphalt field the slower curing asphaltic oils are becoming less popular. Cut back asphaltic materials appear to be paining in popularity.

Hot asphalt or hot tar as a second application in dual

treatment work satisfies several state highway departments.

Premixed asphaltic surfaces are generally hot mixtures. Cut-backs are being tried for mixed-in-place, premixed surfacing and cold penetration macadam. Cold tars for surface treatment and mixed-in-place types of surfacing are giving good service in several states.

A new type of premixed surfacing is a cold patch tar mixed with stone in a concrete mixer.

Bitumens are the most widely used binder in the low cost surfacing field.

Calcium chloride to lay dust and prevent loss of binder is used extensively near its source of supply. Sulphite liquors are *not now* used to any appreciable extent.

Natural rock asphalt when near its source has entered the field of low cost surfacing.

Portland cement with local sand or local fine gravel as an aggregate is a departure from former standards. The possibilities appear to be good for obtaining a serviceable pavement with these aggregates, provided expansion and contraction are properly controlled.

Hard crushed stone or dense hard slag are preferred to sand and gavel in dual treatment work of the penetration type.

Softer and more friable crushed stone when used for this purpose is specified in larger than customary sizes of hard stone.

There is a general preference for crushed materials in surface treatment work.

Clean gravel and clean, coarse sand for this purpose on account of availability and comparatively low cost, are still a popular cover material.

Aggregates for mixed-in-place surfaces are generally those in the roadway surfacing itself. Examples are the work in Wisconsin, California, Indiana and the test road in south Carolina.

Work of a similar character as done in Tennessee and Pennsylvania require new materials as aggregate, for the bituminous surface.

In this type of construction cold asphalt or tar is used as binder. The aggregate may be stone, slag, gravel or sand clay.

Premixed surfaces are usually hot mixes of the standard type, such as bituminous concrete. When used with local sand or gravel the costs have been reduced. Examples are the sand asphalt work in North Carolina, and the bituminous concrete on Cape Cod, Massachusetts.

Convenience in construction and possible economies in plant equipment and operation point with some favor to a premixed cold bituminous surfacing.

Cold penetration macadam is being built in the United States with cut-back asphalt or tar, and in Europe with emulsions.

CONSTRUCTION METHODS

I. Untreated Surfaces.

They are constructed by one of three principal methods:

1. Traffic bound, layer method.
2. Traffic bound, one-course method.
3. Roller bound, one or two-course method.

There are some variations in practice such as obtaining compaction by rolling in addition to that of traffic in both 1 and 2.

1. *Traffic Bound, Layer Method.* The principal example of this on an extensive scale is the recent work in Ohio. It has been practiced also in other states.

The object is to first stabilize the raw, compacted subgrade by the addition of clean, hard aggregates.

Blading and dragging keep the surface regular. Traffic does the compacting. New aggregate is added periodically. This becomes bonded and keyed to that previously placed until a dense and regular surface is obtained. Compaction is thus secured from the bottom or subgrade in successive bonded layers.

The construction operations are simple and consist of hauling, dumping and spreading the aggregates. All of them are done by mechanical equipment. The same equipment is also used for maintenance.

2. *Traffic Bound, One-Course Method.* This method is generally followed for the construction of selected soil, sand-clay and one-course gravel.

After the materials are dumped on the subgrade, the principal operations are mixing in place. This is accomplished by plowing, harrowing and blading. If rains are infrequent, sprinkling with water produces an increased density.

Traffic and hauling of surfacing material finally bring the surface down to a well compacted mass. It may be advisable to use a roller on materials which carry little or no binder. A heavy roller is successfully used on the lime rock bases of Florida which bind together readily.

Some surfaces built by this method are not smooth, because the aggregates were dumped in piles and allowed to stand before being spread and harrowed.

3. *Roller Bound, One or Two-Course Method.* Water bound macadams using various aggregates come under this heading.

The method is primarily to spread a layer of coarse aggregate, shape it, roll lightly and then fill the voids with a finer aggregate. Water may or may not be sprinkled on the surface to assist in the void filling and binding process. Compaction is secured by frequent and protracted rolling.

These surfaces are seldom as smooth as those which use blading or dragging as a part of the construction process.

II. Types Using Non-Bituminous, Cold Admixtures.

The non-bituminous methods may be classed as:

1. The surface application method.
2. The mixed-in-place method.
3. The pre-mixed method.

1. *The Surface Application Method.* Calcium chloride is applied to the surface in flake or powder from a lime spreader. The spreader is hauled by a truck. Frequent light applications of ½ pound per square yard appear to be favored over less frequent and heavier applications.

If a light surface mulch of fine gravel is retained on the roadway surface, the chloride appears to be more effective,.

2. *The Mixed-in-Place Method.* The principal work of this method has been experimental. Lime or Portland cement is mixed with road soils. The soil is first loosened by plowing and harrowing. The admixture is then applied, followed by mixing with plow, harrow or road blader. The final surface contour is obtained by blading. Traffic does the compacting.

3. *Premixed Method Cold.* Although limited in actual work done, this method is included because of future possibilities of utilizing local materials.

Portland cement is the binder.

The binder and aggregate are mixed in a concrete mixer, dumped and spread in much the same manner as standard Portland cement concrete paving. The aggregates are quite fine (all passing three-eighth inch screen), which allows unusual freedom in methods of finishing. A patented cement known as Soilamies cement has never been perfected.

III. Bituminous Treatments and Surface Courses.

New construction methods with bituminous binders have been developed during the past four years. These methods are principally the results of usage with some field experimentation.

As in nearly all classes of road construction, there are three principal methods of construction:

1. The penetration method.
2. The mixed-in-place method.
3. The premixed method.

Bituminous treatments as dust layers will not be covered in this summary.

1. *The Penetration Method.* This method is in common usage for penetration macadam. Quite recently a binder course of penetrated stone between base and top has been developed. The penetration method is used in all types of surface treatment work, that is, surface treatments which include one or more applications of bitumen and one or more spreadings of cover material.

For the dual treatment or two application method, the principal operations are:

1. Cleaning the base.
2. Application of prime coat.
3. Omission or spreading of light cover. (Omission is better).
4. Second application of bitumen.
5. Immediate cover.

Note: The order of 4 and 5 may be reversed.

6. Spreading of cover with brooms or drags.

7. Compaction with a roller or by traffic.

Tightly bound surfaces of stone, gravel, sand-clay, lime rock and various other surfaces are suitable for this method. The smoothness of the resulting surface is almost directly dependent on the smoothness of the surface to be treated.

2. *The Mixed-in-Place Method.* From present indications the main features of the mixed-in-place method are growing in popularity. It is comparatively new. It was developed in Wisconsin about 1923 as a means for forming a bituminous surface on gravel roads which had a loosely bound surface. Today its principal features are used on sand-clay roads, crushed and screened gravel roads, and on old or new macadams.

A surface of appreciable thickness of ¾ to 3 inches compacted thickness may be constructed. The resulting surface is regular in contour and has smooth riding qualities. Minor irregularities in the old surface are automatically corrected by this constructive process.

There are two principal types of the mixed-in-place method; *one* in which *no new aggregates are added* to the *existing surface*, the *other* in which the *base* is *undisturbed* and *new aggregates* are *added* for mixing with the bitumen.

Using Aggregates Already in Roadway Surface.—1. Bring surface to be treated to a regular and smooth contour.

2. Scarify if necessary to the proposed depth of new surfacing, harrow, blade and shape.

3. Apply first coat of bitumen and mix with harrow and road blade.

4. Apply second coat and mix thoroughly.

5. Sometimes a third coat is applied followed by more mixing. Mixing is continued until a uniform color results.

6. Follow with a final shaping by road blade or drag.

7. Secure initial compaction by rolling. Traffic may serve the purpose.

8. A seal coat of bitumen and chips, gravel or sand may be necessary.

Practice in some states calls for a blading of material to the road side. The exposed surface is then treated with a prime coat. This is followed by a second application. The material at the roadside is then bladed over the treated surface and mixed by blading back and forth across the road.

Using New Aggregates.—1. The old compact surface is smoothed and patched.

2. A prime coat of bitumen is applied and allowed to penetrate. It may be left under traffic for several days. A light cover of aggregate may be applied to prevent picking up by traffic.

3. If cover is applied it is bladed or turned over with a road machine set nearly cross-wise of the road.

4. The second coat of bitumen is applied and covered with aggregate.

5. Blading is continued until the cold mix begins to set up.

6. Compaction is preferably secured by a roller instead of traffic alone.

Final cover material may be applied before the second application of bitumen. There is no conclusive data which is the preferable sequence.

A third method may be used in which bitumen is mixed with the materials in the road and compacted in place; followed by the addition of new aggregates which are treated and mixed with bitumen—making in effect two courses.

3. *Premixed Method.* Premixed methods using hot mixtures are so well known that details will not be covered here. The hot mixed macadam as used in Canada differs but little from black base, two-course construction.

The cold mixes are somewhat new, they offer few construction difficulties and interruptions to traffic.

When used on other than concrete bases, a prime coat is growing in favor; as is also a thin bituminous binder course of stone penetrated or mixed with bitumen.

MAINTENANCE METHODS

There are three principal methods of keeping a road surface serviceable:

1. Addition of new materials which are similar to those in the existing surface.

2. Blading and dragging.

3. Patching.

All three methods, including scarifying, may be necessary on any one type of road.

The addition of new materials is common practice, and a necessity on gravel and sand-clay roads. This is done at varying intervals of from one to four years.

Light blading or dragging from two to six times a week, regardless of weather, is the practice in states which have good gravel surfaces.

The heavy road machine and heavy road drag or planer are now being used on water-bound and bituminous macadams, and cold premixed types. Good results in securing a smoother surface are reported. The bituminous macadams are treated with a prime of bitumen the day previous to the planing.

Rollers for practically all types of bituminous surface treatments and surface courses are generally recommended for initial compaction.

The power distributor has practically replaced hand pouring methods for applying bitumens.

Large mileages of low-type surfaces appear to be dependent on mobile equipment for economical construction and maintenance.

For experimental purposes and competition in bidding for work, there appear to be some advantages in having several types of roadway surfaces, but a high quality of maintenance appears to be more easily sustained when the number of types is small.

COSTS OF CONSTRUCTION AND MAINTENANCE

Considering the costs and types of construction in the state highway systems only, the following table is made, for an assumed width of 18 feet.

Types Costing Less than $10,000 per Mile.

Type	Miles
Sand-clay and top soil	11,395
Gravel, chert, shale, etc. (treated and untreated)	19,286
Total	90,681

Types Costing More than $10,000 per Mile (including base).

Type	Miles
Water-bound macadam (treated and untreated)	18,428
Bituminous macadam by penetration	12,927
Sheet asphalt and bituminous concrete	5,706
Portland cement concrete	31,936
Block pavements	3,380
Total	72,377

Surfaces costing more than $10,000 per mile are about 45% of the total, and less than $10,000 are 55%.

If we classify on a $20,000 basis, then water-bound macadams with and without surface treatments come below this figure. We then have 33% costing more than $20,000 per mile, and 67% costing less.

SELECTION OF TYPE

Selection of type is greatly affected by the availability of local materials. Thus we find sand-clays in several of the southern states, gravel in nearly every state in the union, stone in those states which can produce it economically and lime rock in Florida.

Our state highway systems have the largest percentage of high type surfaces, but this amounts to only 33% of their total. Counties and townships have even a smaller percentage.

In their state highway systems Georgia, North Carolina, South Carolina, Vermont and Virginia each have over 1,000 miles of sand-clay; Arkansas, Colorado, Louisiana, Michigan, Minnesota Mississippi, Ohio, Texas and Wisconsin each have over 3,000 miles of treated and untreated gravel; Indiana, Kentucky, Maryland, New York, Ohio, Pennsylvania, Tennessee and Virginia each have over 1,000 miles of treated and untreated water-bound macadam.

A study of Federal-aid road mileage shows sand-clay as 9.3%, gravel, 38%, water-bound macadams, 2%.

For Federal-aids roads, the statement is made by the Bureau that sand-clay is decreasing in popularity, gravel shows little change and water-bound macadam a decrease.

The higher-type surfaces show an increase in popularity on Federal Aid Work, with portland cement concrete showing the greatest gain.

In 1924 the total surfaced mileage in the country was 467,905.

Sand-clay	13.6%
Gravel	52.2%
Water-bound macadam	12.9%
Surface-treated macadam and gravel	5.7%
All other types	15.6%
	100.00%

Among the several untreated types of surfacing, the traffic-bound stone, slag or gravel surface as built in Ohic is an excellent example of good low-cost road service.

Calcium chloride in Michigan has served as a satisfactory dust layer on gravels.

The dual surface treatment work on lime rock in Florida is excellent.

The mixed-in-place methods for resurfacing old macadams as practiced in Pennsylvania and Tennessee are smooth and serviceable.

The mixed-in-place methods on gravel or stone surfaces as practiced in Wisconsin, California, Indiana and Minnesota give promise of a satisfactory method of greatly improving many miles with this type.

The dual surface treatments as practiced in Maine on gravels, and in North and South Carolina on sand-clays, show reasonable results.

The experimental work in South Carolina for improving the serviceability of poor-quality sand-clays is a step in the right direction.

Selection of type is a prescription proposition. An engineer who is already familiar with the local conditions of his own surfaces, available materials and funds, will do well to make an examination of the work done by others under similar conditions. His final choice will be more easily and intelligently made.

SELECTION OF CROSS SECTION

From a study of typical cross sections there appear three principal types for untreated surfaces; the feather edge, from out to out shoulder; the trench section of uniform thickness; and a combination of the trench section for the middle two-thirds which is topped with a feather edge section extended to the outer edges of the shoulders.

Surface treatments and surface courses are usually of uniform thickness. They extend in most instances over the entire width of old surface.

Edge strengthening is being considered, as evidenced by sections which show a wider base than top, a thickened edge similar to the Bates section, the use of headers of bituminous concrete, portland cement concrete or timber.

A section stepping up by using a decreasing width of surface for the various courses is shown by one state.

There is a marked tendency toward flatter crowns. Few exceed ½ inch to the foot, many show in plan and in the field ⅜ inch to the foot and some recommend and use as low as ¼ inch. The growing popularity of the flat crown is apparent in untreated surfaces, surface treatments and higher type pavements.

SERVICE

Road service is frequently reckoned on the cost of maintenance per vehicle-mile or per ton-mile. There is no good reason for not including the cost of construction.

A few states are trying to make their selection of type on the cost of maintenance basis. Reports indicate that they have not made definite conclusions as a result of their observations.

Based on statements and claims made by highway engineers in responsible authority, the following data are presented:

Sand-clay surfaces cost from $1,000 to $2,400 per mile; they will carry from 150 to 550 vehicles per day, including light trucks, at an annual maintenance cost of $300 to $600 per mile.

Gravel surfaces cost from $4,000 to $10,000 per mile and will carry from 250 to 550 vehicles per day, including light trucks, at an annual maintenance cost of $300 to $600 per mile.

Untreated water-bound macadam surfaces cost more than gravel.

Traffic-bound stone, slag and gravel surfaces cost about $2,000 per mile the first year, $1,000 the second, and $500 the third. They will carry 300 to 600 vehicles per day, including light trucks.

Dual bituminous treatments on good substantial bases cost $1,000 to $3,500 per mile for the first year, and will carry from 700 to 1,000 vehicles per day, including light trucks, at an annual maintenance cost of $400 to $1000 per mile.

Mixed-in-place bituminous surfaces, depending on their thickness, are costing from $1,000 to $4,500 per mile, and are reported to be carrying the same traffic as dual treatments at about the same maintenance cost. They are smoother riding than dual treatments, and they should be more durable.

Premixed surfaces and penetration macadam cost from $8,000 to $15,000 per mile and will carry from 1,500 to 2,500 vehicles per day at an annual maintenance cost of from $200 to $500 per mile. In some instances they are carrying heavier and denser traffic.

Tire wear has been shown to be heavier on untreated surfaces.

Traffic-bound and mixed-in-place surfaces are smoother riding than surfaces which are rolled only.

Character and quality of service are affected by climatic, soil and organization conditions.

Gravel roads require more frequent scarifying in states which have severe frost conditions.

Dust is a much more serious problem in Arizona than in Alaska.

Several states reduce the number of vehicles and their weights during the period when frost is leaving the ground. A reduced maintenance cost results.

Soft Stone on English Roads

In our January issue we described the use of a soft limestone as a base for asphalt-top roads in Florida, the wearing surface commonly used on such base being that known as upward penetration. The December 9 issue of "The Surveyor," an English publication, describes remarkably similar work which has been done in England. The article was written by E. H. Stevenson, divisional surveyor of Oxfordshire County Council.

He stated that in many parts of Oxfordshire an oolithic limestone is found which is essentially a soft stone which varies considerably and care is taken to throw out the very soft lumps. It is quite easy to quarry, the cost of the quarried stone being about $1.10 per ton. It is passed through a crusher with the jaws set at 2¼ inches and all the material, including the dust, is used in the construction of the road.

In using this on an old road surface, a layer of dust about ½-inch thick is spread on the old road and this is followed by a layer of the larger material, from 2¼ inches down to ½ inch, which is spread to a thickness of 4 inches. This is then thoroughly consolidated so as to give a 3-inch. layer. As soon as the stone has been well consolidated with a ten-ton or twelve-ton roller, the surface is watered and rolled until the layer of dust and smaller stone have filled the lower interstices of the larger graded stone, thus forming a binder for the base of the stone coating. Six men spread and roll an average of 5 tons a day, covering 550 square yards in a day's work.

While the surface is still wet it is semi-grouted with "Colas," as asphalt emulsion, at the rate of ¾ of a gallon per square yard. A few minutes later the grout is covered with a coat of clean half-inch gravel and rolled. After a few days the asphalt works up into the half-inch gravel. A coat of the emulsion is then appled at the rate of ¼ gallon per square yard and covered with fine gravel and again rolled. The first coat is applied by a hand-drawn machine, but the final coat can be applied by a pressure tank spraying 4,000 gallons in one day. As a wet surface is no hindrance to the action of the binder, the work can be carried on at any time except during periods of heavy rain or frost.

The total cost is given as 52c. per square yard, of

which about 27c. is for lightly scarifying the road, and hauling, spreading and rolling the stone, and the balance for the grouting and graveling. This type of pavement has been in service on some main roads since the autumn of 1923 without appreciable deterioration. There has been no bleeding or moving during hot weather, no appreciable corrugation, and only occasional pot holes which have been easily and quickly repaired by the use of cold emulsion.

Diminishing Yield of Wells

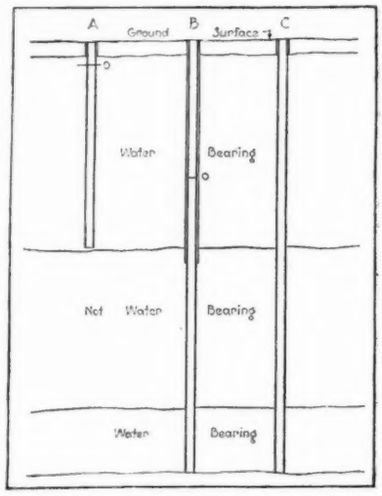
Chief cause apparently is increased rate of pumping. Other causes suggested are deposit of minerals on sand grains, mechanical clogging, and compression of strata. Prevention by regulating rate of pumping

A considerable percentage of the cities in the central part of the United States draw their public water supplies from deep wells, and many of these are becoming quite concerned over the diminishing supplies that these wells are yielding. This subject was discussed last year in a paper presented before the Chicago convention of the American Water Works Association by G. C. Habermeyer, engineer of the Illinois State water survey, under the title of "Well Water Recession in Illinois;" and in another paper by Robert W. Moore, consulting engineer of Indianapolis, presented before the Indiana section of the American Water Works Association, his paper being entitled the "Economical Limit of Deep Well Production." Both of these papers were published in the December issue of the "Journal" of the American Water Works Association.

Mr. Habermeyer began his paper by stating that an artesian well 711 feet deep was drilled in Chicago in 1864 and the water exerted a pressure at the ground surface of about 80 feet. The owners of this well expected to drill others and supply water to the city without pumping, but as the number of wells have been increased, the water level has receded until many wells have been abandoned on account of the high cost of pumping from great depths. An important factor in the lowering of the water level has been the increase in the quantity of water pumped, and this is discussed by the author under the three headings of: (1) wells into porous material overlaid only by porous material; (2) wells piercing several water bearing strata with water from all but the bottom stratum cased out, and (3) wells piercing several water bearing strata with no water cased out.

In the first case, with little lowering of the water level the yield may vary nearly in proportion to the lowering. As the bottom of the stratum is approached the relative area of flow decreases and the velocity increases more rapidly, giving higher friction loss and greater lowering in proportion to the yield, until the bottom of the stratum is reached, when increased lowering gives no increase in yield. If pumping at a rate higher than that at which the water enters the stratum is continued, it will cause a continued lowering of the water level until it is near the bottom of the stratum, when the yield will decrease.

A great majority of deep wells secure water from more than one stratum, as in case three. All the water pumped from well C in the illustration will be from the stratum from which water rises the higher, until the water level is drawn down below the depth at which it stands in either well A or B. Then, with increased pumping, water will be drawn from both strata and the rate of lowering with increased pumping may be a little less or very much less than before.



WELLS OF CLASSES A, B AND C

Drilling and pumping from additional wells in an area may change conditions on account of the quantity of water pumped greatly exceeding the capacity of strata which had supplied all or nearly all demands. The U. S. Geological Survey has developed a current meter to determine velocities at all depths in flowing wells and thus determine the flow into or out of the well from each of the several strata.

All three types of wells are illustrated by a well used twenty years by the village of Western Springs, a few miles west of Chicago. This well was 2,046 feet deep, was cased for 1,765 feet to Mount Simon sandstone, and was very large at the top, giving a well into Niagaran limestone outside of the deep casing. Pumping at the rate of 110 gallons per minute from Mount Simon sandstone lowered the water level inside the casing from 150 feet to a depth of 240 feet. Pumping large quantities from Niagaran limestone outside of the casing lowered the water level a few feet. Shortly after the well had been completed water both inside and outside the casing stood 15 feet below the ground surface, and 600 gallons a minute could be pumped with a lowering not exceeding 6 feet, the well then being of type C, and all water being from the upper part of the well.

Some have thought that increased rate of pumping is not the only cause of the lowering of water levels, but a lowering due to pumping, by reducing pressure, releases gases from the water and causes a readjustment in dissolved mineral matters and a deposit of part of them on the sand grains, thus increasing the friction loss and adding to the lower

on equipment taken from some wells. Also growths on the walls of wells and in the strata are given as possible causes of decrease in yield or lowering of level to maintain the same yield.

Another cause is mechanical clogging of strata with fine sand or other material, which adds greatly to the friction loss and thus to the lowering of the water level. (This is the subject discussed by Mr. Moore in his paper.)

Meinzer & Hard, in Water Supply Paper 520 of the U. S. Geological Survey, give compression of water bearing strata as an explanation of lowering water level. The lowering of head due to pumping reduces the pressure in a stratum, without reducing the pressure above the stratum due to the superimposed material, and this gives compression which reduces the voids and thus increases the friction and also explains a lag in adjustment of water levels with changes in yields.

Mr. Habermeyer gives some definite figures concerning the stock yard area in Chicago and vicinity. It is estimated that the quantities pumped per day for the entire state of Illinois are from 70 to 75 million gallons, 50 of which are from Chicago and suburban areas, 30 from Cook County, 15 from the city of Chicago alone and 10 million gallons per day from the stock yard area. The largest yields are from wells into Cambrian sandstones, which supply about 95 per cent. of the quantity given for Chicago and the suburban area, and probably 85 per cent. of that for the entire state. In the stock yard area water stood at the ground surface in 1889 and lowered gradually and somewhat uniformly to a depth of 212 feet in 1914, when the amount pumped per day was about 13,450,000 gallons in the stock yards and 30,100,000 gallons in Chicago. Since 1914 many of the wells have been abandoned because of both the increasing cost of pumping from greater depths and the superior quality of the city's water supply. The quantity pumped in the suburbs, however, has increased very rapidly. In May, 1927, the water in one well in which the pump had been idle for a day stood at 300 feet below the ground surface, and while pumping 800 gallons a minute the depth was approximately 340 feet. Approximately the same depths or levels are found at points from 6 to 8 miles south and southwest of the stock yards. At Maywood the water level fell approximately 180 feet between 1907 and 1927. At Park Ridge the level fell about 67 feet between 1914 and 1927. At Rockford the level fell about 50 feet between 1885 and 1923.

"About the only conclusion that can be drawn at this time seems to be that the water level lowering depends in large part directly upon the quantity of water pumped and that part of the change is due to some of the other factors which have been given as possible causes. The great lowering near Chicago may be due in part to compression of strata.

"In the vicinity of Chicago, where the greatest quantity of well water is used, much of the water is now from wells drilled as deep as can be drilled without securing salty water, and the water level has receded until some wells have been abandoned, so it may be that conditions will be more uniform during the next few years and additional information can be obtained."

Mr. Moore in his paper says: "Wells penetrating water bearing sand and gravel in which the sand is very fine present problems for which satisfactory solutions have not yet been offered and when properly solved will indicate the number of gallons per minute or the rate of pumpage which such a well can be called upon to deliver safely without shortening its life or diminishing its usefulness.

"Assuming that a well penetrating such a water-bearing sand and gravel has been properly developed and equipped with a screen of rust resisting material, we then have two main questions which determine the undiminished yield of that well over a period of time. The first is the pumping level of the water in the well; and the second, the limit of velocity or rate of flow of water through the water-bearing sand and gravel to the well. The former can be readily ascertained and controlled.

"The practical answer to the second question will indicate the number of wells and the rate of pumpage from each that should be installed in any given sand and gravel deposit of whatever degree of fineness to produce a constant yield of water over a period of years equal to the life of the well casing and screen."

As water flowing through the sand approaches the well at an ever increasing velocity, the capacity to dislodge and carry forward particles of sand increases enormously and sand is drifted toward and through the screen into the well. If all of the sand carried forward by the water passed into the well there would be no problem of diminished yield, but, unfortunately, this is not the case. Sand so brought forward tends to lodge outside of the strainer and each grain of sand so lodged increases the difficulty and in a short period of time wells located in such sand and gravel strata build up a wall of sand around the screen through which the water passes with an ever diminishing volume until the usefulness of the well is at an end.

"It would seem that the only way to control this so-called 'sand-jamming' around the screen is to ascertain by experiment the rate of pumpage which will not produce a velocity of water through the sand sufficient to carry the particles of sand forward toward the well."

An Elevated Concrete Water Tank

A number of concrete standpipes, with bottoms resting upon the ground, have been constructed in this county, but only a few concrete tanks supported on columns, we believe; and none with a bottom construction similar to that illustrated herewith. This is located at Kemsley, England, and was described as follows by the designing engineer, G. T. Cotterell, in a paper before the Institute of Sanitary Engineers:

The water tower at Kemsley, which was recently inspected by members of this institution, has a capacity of 100,000 gallons, and its top water level 48 ft. 6 in. above the ground level. The tank is supported on eight columns, which have no traverse bracing. A great point made in its design is that it should, as

far as possible, harmonize with the garden village upon which it is erected.

The tank is cylindrical, covered with a domed roof. The floor is shaped into an outer frustrum of an inverted cone and a central dome. To provide access to the tank and to shield the pipes from view, a cylindrical concrete access shaft rises from the ground level through the floor of the tank to just above the top water level.

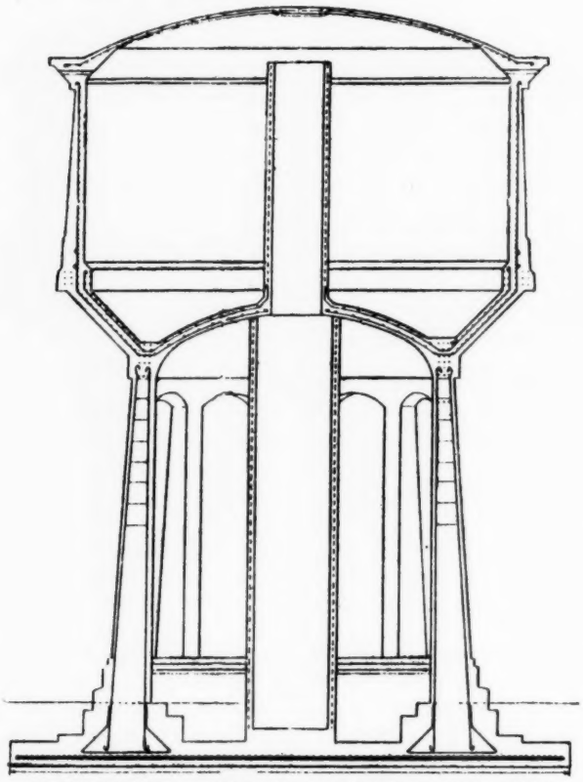
The stresses in the roof dome, due to wind pressure and snow, are taken to act tangentially to its surface, and thus the reinforcement is placed to radiate from the centre towards the circumference. These bars are braced together by ring bars, which are not designed to take up any stresses, but are very necessary to prevent temperature cracks due to the sun on the exposed concrete surface of the roof.

The radial thrust at the circumference of the dome is picked up horizontally in a hood ring beam and vertically in the cylinder wall of the tank.

The wall of the tank is designed on the cylinder principle, with reinforcement to pick up tensile stresses which occur due to the bursting pressure of the water.

At the base of the wall the vertical stresses are split up into a horizontal component and one in the direction of the head of the columns. This horizontal component is picked up in a ring beam, while the other component is taken up in the frustrum portion of the floor.

The frustrum portion of the floor has to withstand bursting pressure due to the water as well as the component stress from the walls, and it is reinforced accordingly with ring bars and radial bars.



REINFORCED CONCRETE WATER TANK WITH ARCHED BOTTOM

The dome portion of the floor is designed in a similar manner to the roof. It will be seen that there are two resultant thrusts at the circumference of this dome and at the base of the frustrum which tend to oppose each other, and, as far as possible, these two thrusts are designed to balance when the tank is full.

To take up these thrusts, a ring beam is constructed at the head of the columns, which is also designed to take up bending stress in spanning continuously across the columns.

The whole load is taken up on the eight columns and care is taken to avoid any support from the access shaft by placing a bitumen joint at the underside of the dome.

These columns are designed on the "Rankine" theory to withstand direct and buckling stresses. Consideration has also been given to additional stresses caused by the overturning moment of the wind pressure.

Before the foundations to the columns were put in, trial holes were excavated on the site, and it was found that the gravel foundation was not good enough to take a load of 2 tons per sq. ft. So it was decided to increase the area of the raft and reduce the bearing pressure to three-quarters of a ton per sq. ft.

The reinforcement in the raft is sufficient to withstand shear from the columns and bending stresses due to the upward earth thrust.

The tank has an inside diameter of 34 ft. and a height of about 30 ft. from top of column to top of domed roof.

The Madras Water Supply

Last November, in a paper before the Institution of Water Engineers of England, J. W. Madeley described at some length the failure of slow sand filters in Madras, India, to satisfactorily purify the water supply of that city. During the discussion of the paper the president of the society quoted from a recent "best seller" called "Mother India" the statement that the water supply of the city "is passed through slow sand filters into a pure-water tank at the rate of 10,000,000 gallons per day, but the population of Madras has increased and the capacity of the plant is now 4,000,000 gallons short of the daily needs of the town. Detailed plans for the construction of adequate new filters backed by British experts have been laid before the municipal council. But these sixty leaders and guardians of the public weal, Indians all, have adopted a simpler scheme. As I saw and heard for myself from the Indian superintendent on the spot, they now filter 10,000,000 gallons per day, run it into a pure-water tank, then add 4,000,000 gallons of unfiltered sewage, and dish the mixture out by pipes to the citizens of the town."

Commenting on this, Mr. Madeley said that in writing a book about India care should be taken not to suggest that the awful conditions which undoubtedly existed in isolated places were general throughout the country. If we were to take the police court proceedings in England and mention

them in a book as being typical of what was done in England, that, of course, would give a very unfair view of the average Englishman. Similarly it was necessary to read "Mother India" with the same amount of discretion. The statement that Madras water was sewage was of course, not true. Some of the water was not filtered, but was heavily chlorinated. It was tested at regular intervals and the amount required for sterilization was added. Then this water was mixed with the filtered water. The fact remained that there was neither taste nor smell to the water, and there had been water-borne disease in Madras, which really was extraordinary, because there had been a bad epidemic of cholera in other places.

Treatment of Tomato Cannery Wastes

A tomato canning factory in Maryland discharges its liquid wastes into a ditch leading to a tidal stream which is practically landlocked, and which, acting as a settling basin, results in decomposition of the wastes and the production of disagreeable odors. The Bureau of Sanitary Engineering of the State Department of Health began a study of the problem in July, 1926, with a view of ameliorating such conditions, and, although the experiments have not yet reached a satisfactory conclusion, certain tentative opinions have been formed.

The wastes to be considered are the liquids, together with the tomato juices, small pieces of skin and seeds which find their way onto the floor, and may be further subdivided into floor washings, wash water from the washer and scalder, wastes from pulp tanks and from the cooking kettle, and drippings from the packing table trough.

An experiment was conducted using a cypress tank of 6,000 gallons capacity provided with a floating take-off weir and a sludge draw-off line at the bottom of the tank. At the end of each day's operation, the liquid collected in this tank was treated with 6 grams of lime and 4 grams of ferrous sulphate per gallon, the same being mixed in the tank by means of a long paddle. Lack of sufficient funds prevented as complete equipment and procedure as would have been desired.

Experiments with the use of lime and ferrous sulphate as precipitants showed that 6 grams of lime and 4 grams of ferrous sulphate per gallon produced the best clarification, although the decolorization was not as satisfactory as might be desired. But increasing the quantity of precipitants did not improve the results.

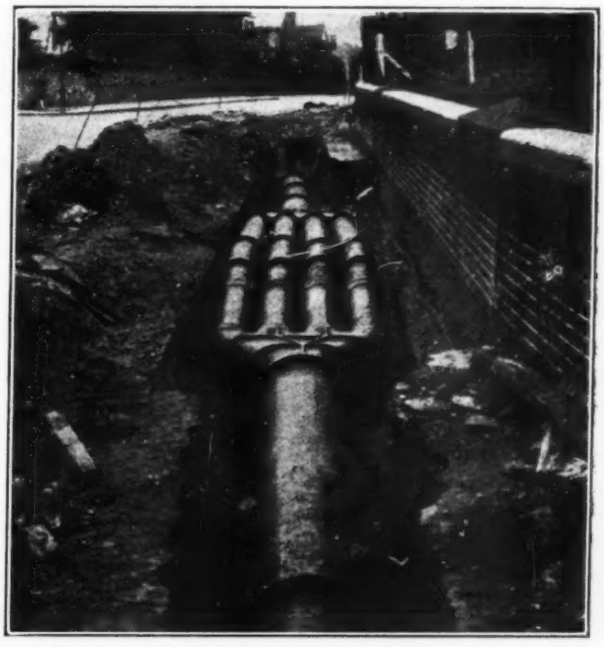
It was found, however, that if the raw waste was subjected to an absolutely quiescent state for a period of 18 to 24 hours it produced practically as clear a liquid as that produced by the addition of iron and lime followed by a quiescent period of approximately two hours. True quiescense was found to decrease the turbidity 71%, the total residue 19%, the oxygen consumed 10%, and the biochemical oxygen demand 77%.

The sludge which is drawn off can be placed one foot thick on a sand or cinder bed and should dry sufficiently in 6 days during the warm weather usually found in the canning season.

Tabulated data of the test show that on September 22 of last year the tank effluent had a biochemical oxygen demand of 3,400 and a pH value of 4.2, the latter being the same as the pH for the raw waste; while the supernatant of the tank effluent after settling one hour had a biochemical oxygen demand of 770 and a pH value of 4.4. The turbidity was reduced to 5,800 p.p.m. to 1,700 p.p.m., but the color remained unchanged at 60. The turbidity and color of the raw waste were not given, but the total residue on evaporation was 11,757 for the raw, 8,738 for the tank effluent as run from the tank, and 7,061 after standing quiescent for one hour.

Water Mains Across Arch Bridge

In extending its distribution system, it became necessary for Guildford, England, to carry an 18-inch main across an arch bridge spanning railway tracks, where the space between the crown of the arch and the level of the sidewalk was insufficient to accommodate a main of this size. The difficulty was met by substituting for the 18-inch pipe four 9-inch pipes, thus reducing the space necessary by about 10 inches. Even so, there were only two or three inches between the top of the bell and the level of the sidewalk. The illustration shows the special castings required for connecting the four 9-inch mains to the 18-inch main.



FOUR 9" PIPES SUBSTITUTED FOR 18" IN CROSSING BRIDGE

Pipe Used in Sao Paulo Aqueduct

In an article in our December issue describing the Sao Paulo Aqueduct we stated, on page 452, that "The . . . pipe will be built of steel plates. . . . All of these [pipes] will be constructed of Armco ingot iron plate." The word "steel" was a slip of the pen to which our attention has just been called. As

stated a few lines below, all the pipe used was of ingot iron.

Photography in Syracuse Engineering Bureau

Recognizing the importance of photographs for supplementing maps, designs and other documentary data on all public improvements under its supervision and jurisdiction, the Bureau of Engineering of Syracuse, New York, during 1927 established a division of photography. Previous to its formation, photographs had been taken by employees of the Bureau and filed for reference, but the extensive improvements planned which would be in charge of the Bureau made it expedient to organize the division, with one man devoting the major part of his time to the work. City engineer Nelson F. Pitts, Jr., states, in his annual report for the year 1927, that at the end of that year the Bureau had on file approximately 2,500 photographs, each numbered and dated, alphabetically indexed, and so filed as to be instantly available. Plates and films are correspondingly numbered and indexed and are also on hand for immediate response to requirements.

"Streets ordered paved, resurfaced, widened, or otherwise improved are photographed before the work is begun and after the contract has been finished, and frequently during the course of construction. Municipal buildings constructed under the jurisdiction of the Bureau are pictured from site to completed structure. Streets and areas in which sewers are ordered are photographed before operations are started and again during the work. Progress in school, fire station, police precinct and other such buildings is recorded by these photographs, forming an invaluable record in conjunction with the other engineering records. In addition to the 'still' photographs, there are on file 25 reels of motion pictures, each 100 feet long, recording progress of actual operations on contracts and showing various other views of municipal progress and routine business.

"The photographic record has face value in its use as evidence in possible legal complications over public improvements, in its accurate registry of contract progress and in its general data supplementary to regular records of the Bureau.

"Air photograph maps provided by the Airmap Corporation of America have proved to be of great assistance in planning for extensions of municipal services such as water and sewer, streets and sidewalks, in the development of tracts, outlying sections and annexed areas. They have greatly facilitated the work by presenting an unexpected view of such districts, indicating what streets are the most largely populated, and in general, locating the sections in which such extensions and improvements should first be made. They have saved time and labor, two important factors in the prosecution of the work in the Bureau of Engineering."

There is also a Division of Records, by which the hundreds of maps, designs and documents of every description pertaining to the functions of the Bureau are filed in orderly manner and are easy to find through systematic indexes and arrangement. These are found invaluable for giving information asked for daily by the public in person and over the telephone regarding details of various public works. All documentary data of every description relating to work under the jurisdiction of the Bureau are on file in this division, protected by steel vaults, and so arranged that any of them can be obtained in a very few minutes.

Electric Advancements in 1927

Advancements in electricity made in 1927, especially those represented by products of the Westinghouse Electric & Manufacturing Company, are described briefly in a 44-page pamphlet distributed by that company. Most of them are of special interest to the electrical or mechanical engineer, but a few are of direct interest to the public and public officials. Among the latter we note the following:

Waterwheel generators of 40,000 kv. a., 82 r. p. m., built for the Conowingo development of the Susquehanna Power Co., have an outside diameter of 38 feet, the largest in the world.

Street cars, to meet the competition of automobiles in comfort and beauty, are being given bright colors, cushioned seats, pleasing appearance. This year have appeared various new cars with new motors, new drives, built for silence, smoothness, light-weight and higher speeds. The first new worm-drive car for Springfield, Mass., follows the general appearance of a bus, with sloping windshields, spring buffers, gay coloring. The trucks are built on worm-drive Timken axles, similar to those used in busses, and including differentials. Four high speed, light-weight motors drive these axles through propeller-shafts, each with two universal joints. Roller bearings are used throughout. The motors, each for 300 volts, were connected in series pairs, and weighed less than half as much as ordinary motors of equal rating. This light weight is gained by the high speed due to large gear reduction; by the extensive use of aluminum alloy; and by the advantages of freedom from road-shock. The electro-pneumatic battery supplied control apparatus was also novel and includes a master controller with vertically-moving lever.

The second new worm-drive street car for Joliet, Ill., with largely similar drive and trucks, except that the latter have a rigid bolster instead of a spring hung bolster, as in Springfield, Mass., was built almost completely of aluminum, weighing only 23,750 pounds for a seating capacity of 50.

Electric welding continues to displace both riveting and casting, and threatens to occupy a large part of both fields eventually. The first all-electric-welded railway bridges have been built this year. One (Boston & Maine) is at Chicopee Falls, Mass. Electric-welded throughout, it was designed to that end, being made of plates without angles. A somewhat similar bridge on the Westinghouse Interworks Railway was built about the same time. During the year, riveted bridges on several railroads have been reinforced by welding. The

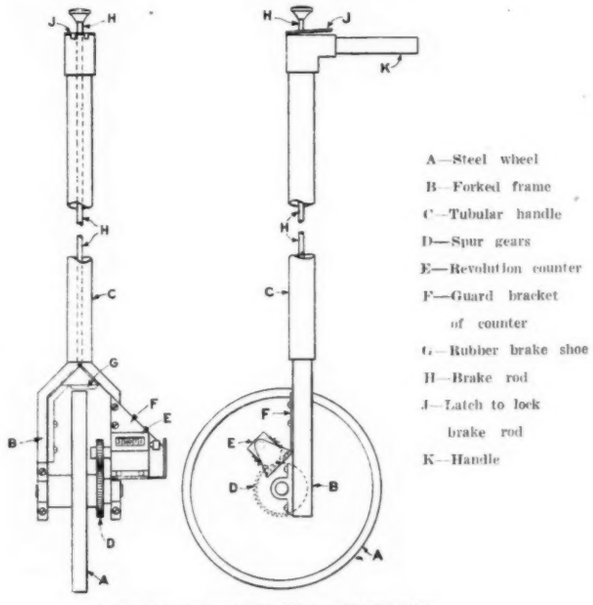
heaviest responsibility yet put on welded structures is a factory building 70 feet x 220 feet, 80 feet high, with floors designed for loads of 300 pounds per sq. foot—the largest, most important, welded building. Riveted, it would have weighed 885 tons—instead of 790, as it stands. Sharon, Pa., Westinghouse plant.

Measuring Cracks in Concrete Pavements

Making condition surveys of concrete pavements usually begins with a determination of the amount of cracking which has occurred, and this involves considerable painstaking labor if done with a tape. An instrument for measuring the length of cracks rapidly and with a satisfactory degree of accuracy has recently been designed by the Division of Tests of the Bureau of Public Roads and was described by H. L. Bosley, assistant materials engineer of the Bureau, in the publication of the Bureau, "Public Roads," from which the following is abstracted:

The apparatus, which embodies the same principle as the chartometer used for measuring distances on maps, consists of a wheel which is rolled along the surface to be measured by means of an operating handle. The circumference of the wheel being known, it is so geared to a revolution counter that for each linear foot of travel one unit is recorded on the counter. Thus, the reading on the counter at any time shows the total distance over which the wheel has been rolled.

The details of construction are shown in the illustration. A steel wheel, A, whose circumference is exactly 2 feet, rolls freely in bearings supported by the forked frame, B, attached to the tublar handle, C. A pair of spur gears, D, rotate the spindle of the revolution counter, E, twice for each revolution of the measuring wheel, A. Thus for each distance of 1 foot traversed one unit is registered on the counter. The counter, E, is supported and protected by a guard bracket, F. In transporting the apparatus from one place to another it is desirable to prevent rotation of the counter spindle. For this purpose a rubber brake shoe, G, is provided and this is pressed against the measuring wheel, A, by the rod, H, which terminates in a knob at the end of the operating handle. The operator simply presses down on this knob and locks the wheel, the brake being held in contact by the latch, J. To release the brake a slight pressure on the end of the latch, J, frees the rod, H, and permits the wheel, A, to again roll freely.



CRACK MEASURING MACHINE

One man with the instrument can replace two men with a tape and obtain the same data more easily and it is believed more accurately. A second advantage is that the actual length of meandering cracks can be accurately measured, something which can not readily be done with a tape. Calibration tests with one of these devices indicated that lengths measured at the speed of a man walking were accurate to within 0.25 per cent. or 1 foot in 400. A check on the individual measurements is available at all times in the total on the counter which will record nearly 20 miles before clearing.

Traffic Stripes on California Highways

By W. A. Smith, Assistant Maintenance Engineer

The Maintenance Department of the Division of Highways has extended the use of the painted traffic stripe to establish traffic lanes on long stretches of heavier traveled pavements. This device had been previously used on state highways at crossings, blind curves and on narrow bridges and the results were so satisfactory that it was felt justifiable to extend its use.

The painting of a stripe on the center of the pavement appears a simple operation, but care is required to secure a satisfactory job. A slight variation in the line is magnified amazingly to the critical eye, and on rough pavement with ragged edges a true uniform stripe is difficult to secure. Before starting the work a number of painting and marking devices were tried out, and the testing laboratory analyzed various brands of paints and made series of tests, resulting in the adoption of a standard specification and equipment. For pavements with uniform edges a wheel device with a marker arm at the center of the pavement may be used. On other pavements, it is neccessary to mark the line by measuring and lining in the center by means of a cable. The paint machine used is hand propelled, on which is mounted a small compressed air spray outfit.

The paint must work rapidly through the spray machine, spread uniformly, dry quickly without becoming chalky and should wear well. The specifications developed were for a comparatively cheap white paint which proved satisfactory on concrete pavements but was absorbed or broken down in a short time by asphaltic and oil types of surface. At present the department is using orange colored lacquer paint on the asphaltic surfaces. About ten gallons of paint are required per mile. Some 260 miles of six-inch traffic line have been painted. The cost varies from about $25 to $55 per mile. The average is about $38 per mile. This cost is higher than originally estimated but it is felt the work is well worth the expenditure. On one section

of the asphaltic desert roads with oiled shoulders, traffic was unable to distinguish the edge of the pavement at night. This caused a number of serious accidents. The white center line now serves as a guide line and accidents have been reduced materially. In fog and on mountain roads, a visible traffic line gives the driver added assurance as he watches it instead of the guard rail or pavement edge. The guide line tends, almost automatically, to hold traffic to the proper lane. It permits of free passing of fast traveling machines, thus speeding up and safeguarding traffic.

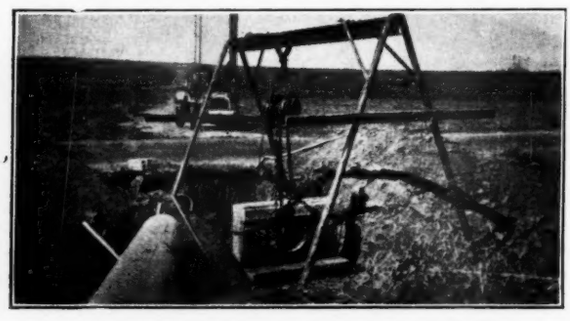
—*California Highways.*

"Gravel for Maintenance" in Oklahoma

The working out of a "gravel-for-maintenance" plan for making dirt roads into all-weather highways is one of the outstanding accomplishments of the Oklahoma State Highway Department during 1927. It was tried on 23¾ miles of highway last year and cost but $1,200 per mile, while paving would cost $25,000 or more. Thus 20 miles of gravel maintenance can be laid for the cost of one mile of paving. Under this plan, 500 tons of gravel to the mile is spread in a one-track width down the center of the road. This coat of gravel is heavy enough to keep cars out of the mud, even on gumbo soil. In good weather most drivers run on the earth shoulder of the road, but in wet weather they use the gravel. No ruts are allowed to form, as a small amount of work with a blade keeps the road smooth. The gravel-for-maintenance work last year cost $28,500. H. A. Parker is county engineer of Tulsa County.

Extending Culverts in Road Widening

During the past three or four years a considerable percentage of the amount spent by the State of California on its highways has been used for widening previously constructed concrete pavements. This, of course, necessitates not only the adding of side strips of pavement, but also the construction of new shoulders and the lengthening of culverts and widening of bridges. While the widening of bridges may be delayed somewhat, the lengthening of the culverts must of course be a part of the original widening of the road. Division VII of the Highway Department has adopted an economical plan for extending the culverts without destroying the head walls. Thirty corrugated culverts were so extended during the widening and repaving of the state highway in San Diego county during the past year.



MOVING CULVERT HEAD WALL WITH PORTABLE CRANE

A special maintenance crew was employed and head walls were moved in record time by the use of a hoisting frame designed and built at the division shop at Lankershim. The hoist consisted of a ten foot length of 6-inch I-beam supported by four 2-inch pipe legs and capable of adjustment to a height of 6 to 8 feet. A trolley carrying a two-ton chain hoist operated on the I-beam and was adjusted to move freely along the length of the hoist. The earth around the headwalls and down to the bottom of the footing and extending out from 6 to 10 feet was excavated to provide room for moving. The excavation also extended from 2 to 3 feet back of the head wall to permit cutting the corrugated metal pipe about a foot back of the head wall. After the pipe had been cut, the hoisting frame was lifted into place and the hoist chain was hooked on the back above the pipe and a turn taken around the top of the head wall just below the offset. The head wall was then raised and moved outward to the new location by means of the trolley. Corrugated pipe of the same size as the original culvert and cut to the proper length was then inserted and fastened in place at the two ends with two coupling bands.

The cost of this work was reported as follows: Average cost of moving ten 12-inch culverts, $5.15 each for excavating and backfilling one end, $1.35 for cutting pipe and moving the separated head wall, and $3.25 for setting in the pipe extension; making a total cost of $9.75 for one end. Head walls for twelve 18-inch culverts were moved a distance of ten feet and the pipe extended at an average cost of $7.96 for excavation and backfilling, $1.75 for cutting the pipe, moving out and leveling up, and $2.75 for setting in the pipe extensions, making an average total of $12.46. Eight 24-inch culverts were moved a distance of 7 feet at an average cost of $12.60 for excavation and backfilling, $2.85 for cutting pipe moving out and leveling up, and $3.25 for setting in the pipe extensions; making a total cost for extending each end of $18.70.

Sabine River Highway Bridge

The highway bridge recently completed across the Sabin river at Orange, Texas, and the embankment and relief opening across the adjacent Sabine swamps in Louisiana, are termed by G. W. Mayo, highway engineer, Bureau of Public Roads, as "one of the outstanding achievements of the two State Highway Departments concerned." These two form a link of U. S. Highway No. 80, known as Old Spanish Trail. They will take the place, for the traveller, of a four-mile ferry service which entailed a delay of an hour of more.

The construction of the bridge, which was under taken by the Texas department, was both difficult and expensive. The bridge consists of a 315-foot swing span with a 75-foot steel span at each end. The approaches consist of 285 feet of timber trestle on the Texas side and 400 feet of the same on the

Louisiana side. These approach trestles and steel spans are built with vertical curves to afford easy transition to the streets of Orange, and to the Louisiana embankment. There is a clear roadway width of 20 feet on the steel spans and of 21 and 23 feet respectively on the trestle approaches. The structures throughout are provided with an asphaltic wearing surface.

The swing span is supported on a pivot pier and the normal depth of water here is about 39 feet. To avoid any chance of undermining this pier by scour, it was decided to carry the pier to a depth of about 30 feet below the river bed, giving the total height of the pier from base to top of 83 feet 3 inches. Construction of the pier involved sinking a hollow reinforced concrete cylinder 30 feet 6 inches in diameter and 39 feet high with a shell 12 inches thick, and driving 106 timber piles an average length of 66 feet.

Sinking the caisson was accomplished by interior dredging and weighting the casing to overcome friction on the side. Rings of sheet steel five feet high were bolted to the top of the caisson successively as it was lowered, to keep the top above low water level at all times. Driving the 66-foot piles in the bottom of the caisson was found difficult both because of the nature of the subsoil and because of the unsupported length of piles above the bottom of the dredged-out caisson. It was found necessary to use both a guide tube over the top of the piles and extending practically to the ground line and a follower so that the steam pile hammer could be kept above the water line.

After the completion of the sinking of the caisson and the driving of the piles, a four-foot seal course of concrete was deposited at the bottom of the caisson and the latter was then filled with sand to a depth of 27 feet, followed by a second seal course of 18 feet of concrete. This gave a water-tight bottom and the caisson was then pumped out and the rest of the concrete placed in the open. The top 28 feet of the pier was stepped in and constructed as a hollow reinforced concrete shell 25 feet in diameter.

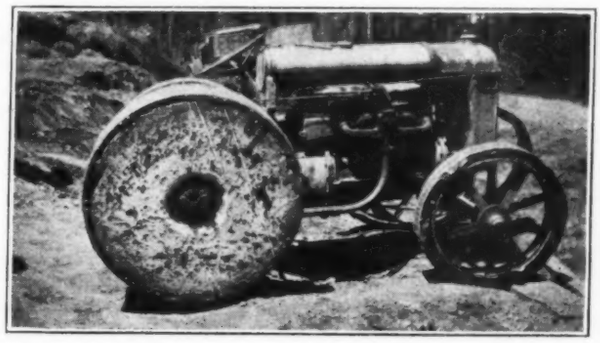
The swing span is of the center bearing type resting on a phosphor bronze pivot disc 24-inches in diameter. The machinery operating the span will be operated by electric power, which will open and close the span in three minutes. The construction of the bridge required the use of 8,100 linear feet of untreated piles, 8,400 linear feet of treated piles, 88,000 feet board measure of treated timber, 2,133 square yards of asphalt surface, 1950 barrels of cement, 245 tons of structural steel, and other materials. Herbert Eldredge was resident engineer on the Texas work and the contractors were the Womack Construction Company and the Brown-Abbott Co., Inc.

Highway Constrution in Davison County, S. D.

In an article in the January issue, page 4, describing "Heavy Highway Construction in Davison County," this county was incorrectly given as being in North Dakota. The county, and the work described, are located in South Dakota. We wish to apologize to the author and our readers for the mistake, which was not discovered until after the issue had been printed and mailed.

Tractor as Road Roller

A highway contractor in Georgia, desiring to obtain a road roller for a comparatively small job without the expense of buying one especially for this purpose, constructed from a Fordson tractor a substitute which is said to have proved satisfactory. Weight was obtained by filling solid with concrete the two large rear wheels. The steering flange or fin on the front wheels was prevented from cutting the pavement which was being rolled



ROAD ROLLER MADE FROM TRACTOR

by being encased in a false rim. Wooden felloes were placed around the outside of front wheel, one row of felloes on each side of the fin, and around this was placed a strip of sheet metal wide enough to permit each edge to be turned down over the felloes. These edges were pierced and the metal false rim was held in place by wires passed through these holes and inside the rim of the wheel.

Since it would not be desirable to use the heavy rear wheels when the machine is operating as a tractor, a duplicate set of wheels were obtained for this purpose, and the loaded ones removed when the tractor was not rolling.

House Numbering in Syracuse

The Division of House Numbering of the Bureau of Engineering of Syracuse, N. Y., follows a regular system in numbering houses and properties throughout the city. A number is assigned for each 20 feet of frontage on each side of the street. Each block is assigned one, two, or more hundred, according to its length. Two streets approximately at right angles were selected as axes for the numbering, and the even numbers north of one axis are assigned to the east side of the street and odd numbers to the west side, while south of this axis the reverse is true, the even numbers being on the west side and the odd numbers on the east side; the same idea being carried out in numbering the east and west streets to the east and to the west, respectively, of the north and south axis.

In establishing the system, location surveys were made to determine the position of all houses, and these were plotted on maps of the streets, together

with the lot divisions, and each 20 foot space was assigned its proper number, and this number assigned to the house upon it or to be erected thereon, according to the location of doorways within the 20-foot strip. According to city engineer Nelson F. Pitts, Jr., "The importance of having all buildings systematically and visibly numbered cannot be emphasized too strongly. It should be made obligatory that property owners number their property so that the numerals can be seen easily and plainly from the roadways and sidewalks. The city is serving the public convenience by assigning definite numbers in such a manner that future building will not cause confusion or the employment of half-numbers."

A Garbage Disposal Report

Data and opinions contained in convention report of International Association of Street Sanitation Officials. Lack of reliable figures of weights of collections make comparisons difficult. Reform necessary in methods of letting contracts.

Interesting data concerning garbage disposal in a number of cities of the country were given in a report presented at the annual convention of the International Association of Street Sanitation Officials by the committee appointed to study costs and methods of various garbage disposal systems, of which Carl Schneider, of New Orleans, was chairman.

In summarizing certain of these data, the committee stated that separation of various classes of refuse by householders is generally required in the northern and eastern cities; that southern cities nearly all have mixed collection; while both methods are to be found in western cities. Wrapping of garbage is frequently required in cities disposing of refuse by incineration and occasionally in cities where the garbage is fed to hogs, particularly in the winter.

In most cases garbage is hauled to disposal sites in the vehicles used for collection, but supplemental transportation is also found by trucks, tractor-trailer trains, railroads, scows and barges. The use of animal-drawn trailers for house-to-house collection and the towing of such trailers in trains for the not uncommon long hauls to disposal sites, have proved distinctly economical and this method of transportation has made strong advance in recent years. For best results, this system of transportation requires close scheduling and highly efficient maintenance of collection and supplemental towing equipment.

An interesting development in this connection was found in New Orleans, where all refuse is mixed. A study of transportation by truck-trailer trains in comparison with transportation by railroad showed that the former method cost 65.4c. per ton and the latter 67c. per ton, the latter figure including 43c. per ton for wages of station keepers and 24c. for shipping charges, which were $5 per car. This condition is somewhat explained by the fact that the haul was rather short, 5 to 7 miles in either case, but the principal reason can be found in the bulkiness of the material. The mixed refuse weighs about 600 pounds per cubic yard, and hardly more than 20 tons could be placed on a railroad car, the carrying capacity of which, however, was originally 40 tons. The ample reserve capacity in the cars was a wise provision in that depreciation of the structural members has been excessive due to the highly corrosive action of the garbage.

The committee gives as the component parts of the entire problem of refuse disposal: (1) the house treatment, including the preparation and separation of the materials to be handled, the type of containers, and the location from which the collections are to be made; (2) the collection, concerned with the vehicles, their motive power, accessories and personnel; (3) transportation of the loads collected to the point of disposal; (4) the disposal of the material and its residue or product.

The essential features of an efficient garbage collection and disposal system are given as: (1) sanitation; (2) service; (3) economy; (4) dependability and flexibility; (5) expediency.

"Time, effort and expense spent in preliminary study are sure to be well spent in the light of after-results. The best system will usually not be the most economical from a bookkeeping point of view. The indirect benefits to a community's general welfare can not be figured at their real value, but will most certainly justify the additional expense necessary for an efficient system."

In endeavoring to compare costs of the work done by different cities, "by far the greatest drawback to true comparison lies in the fact that weighing of the refuse is not generally done. Other factors that affect comparisons would include wage rates; frequency of collections; collections from curb, alley, or rear of houses; type of collecting equipment; number of employees to collecting unit; topography, especially with reference to grades and street conditions; length of haul to disposal point; methods of disposal; character of refuse; and numerous others."

Although there is such a formidable list of variables, there are certain phases of the work that are highly susceptible to comparison. "For example, the man-hours per ton for incineration is becoming of increasing importance in the guarantee ratings of incinerators. It does not tell the whole story, for such items as fuel and power are often quite material charges against the cost of disposal by this method. The costs of transportation per ton-mile are also usually comparable. By and large, how-

ever, general comparisons seem to be off in the distant future. Concerted agreement between city officials on standardized methods brought about through such bodies as the I. A. S. S. O. can do much useful work in this direction."

"In the analysis of a city's refuse problems, too much emphasis cannot be placed on the care with which the disposal method should be decided upon. It should not be the whim of influential politicians nor a haphazard guess by the municipal officials. It is usually a task for an engineer especially trained in this line of work. The city officials, who, by careful study, could qualify to handle the problem, are usually burdened with detail and routine work to such an extent that they cannot afford the time necessary for a complete study of the problem with all its possibilities. Furthermore, the municipal official often has to work with his hands tied in one form or another."

Local conditions play an all-important part. "In warm southern climates ashes usually present no significant problem; but on the other hand, for sanitary reasons, more frequent collections of garbage are necessary than in colder climates. In a very limited number of cases it is possible to dump garbage in the ocean. There are wide variations in the characteristics of the refuse, depending upon climate, season, and population. St. Petersburg, Florida, reports a winter population three times as large as the summer population. Again, Doctor E. T. Hanley, health officer in charge of refuse service in Seattle, Washington, declares that that locality is peculiarly adapted to disposal of garbage by sanitary fill. The winters are mild, the summers are cool; no fly nuisance in summer and no ice and snow in winter. Besides, the topography of the place is exactly suitable.

"A study of local conditions should include, above all, the character of the refuse to be handled—production day by day for the year, fuel and food values, moisture content, and the effect of the seasons. Other factors pertaining to local conditions that should be considered are: sites available for disposal plant, topography, markets for possible products, and existing facilities."

The report discusses the various features, advantages and disadvantages of disposal of garbage by dumping, by feeding to hogs, by reduction, by incinerator, by burial, by the manufacture of stock feed, and by the Beccari process.

Incineration appears to be meeting with more favor recently than any other method of disposal. Discussing this method of disposal, the report states that "It is hardly possible to burn mixtures leaner in fuel value than 65% garbage and 35% rubbish with continuous satisfaction. For some types of plants much more rubbish than 35% is required. The failure to make up deficiencies in rubbish with auxiliary fuel is the bane of incineration operation.

"Moisture is the 'thorn in the flesh' to incineration. The less moisture in the refuse, the easier it will burn; consequently, proper house treatment, and covering the vehicles during rainy weather, especially, will do much to make incineration easier.

"The economically correct size for an incineration plant will vary with different cities. The length of haul for collection vehicles, density of population and other factors will be worth careful study. While operation costs usually are less, the larger the plant, the congestion of the collection vehicles at very large plants is sometimes the cause of neighborhood complaints. Incinerators should preferably be located in industrial neighborhoods, as near as possible to the center of production of the areas to be served by them."

Although incineration has made greater advances than any other method in the past decade, there is still a bountiful field open for more and better incinerators. There is need for improvement in the incinerator design and an equally strong need for more equitable letting of contracts for incinerators. In the matter of design, there is special need for improvement in combustion control and handling of the materials. Probably lack of complete engineering test data on incinerator plant performances, in the sense that such data are available for power plants, have retarded improvement. Such test data are not so easily obtainable, in view of the variable character of the refuse. Calorific values of garbage and rubbish mixtures will vary to such an extent that an average for accurate test purposes is impracticable. Such is not the case with coal, oil, or gas as a fuel.

Competition for incinerator contracts is usually between the manufacturers or holders of patents and not healthy competition between local contractors. It usually embraces the entire plant, although only the furnaces and attachments are the subjects of patented design, and all other features of the plant are possible of construction, purchase and installation by a local contractor.

"The trouble is really rooted in the specifications on which bids are received. There have been many variations of specifications but few on sound principles. The advertisement for bids on general specifications, merely stating the duty to be performed, general character of building, and which contains only loosely written guarantees, only invites trouble for the city fathers. In general specifications, too much opportunity is usually afforded contractors to trim their costs of construction after award is made. Contractors for the more expensive type of incinerators, in trying to compete with the cheaper types, often omit from their designs parts of special importance to efficiency and sanitation. The low bidder appeals to the taxpayer with the money-saving-on-first-cost idea. The public official, confronted with the task of selecting the best bid, is between the devil and the deep sea. On the one hand he often fears the consequences to the work from the cheap plant, and on the other hand the fear of public disfavor by accepting any but the lowest bid makes him feel like 'passing the buck' to some one else." Expert engineering advice frequently is sought at this point in selecting the best bid, but this is usually too late—the time for expert advice was when the project was initiated.

As a remedy for these conditions, the committee suggests that there be more general knowledge of the fundamentals of the problem among municipal officials who are concerned with the construction of incinerators. Information from promoters or manu-

facturers of plants is likely to be biased and consequently misleading. "It is also suggested that the highest integrity, absolute freedom from political interference, and subordination of egotism would help the cause. The best interests of the city should be considered exactly in the same light as would those of a corporation. Annual costs of operation and fixed charges should be the yard-sticks of comparison, more than initial cost.

"In the preparation of plans and specifications for any project, particular care should be exercised that requirements be stated in detail as much as possible. The separation of the various items in the bidding, such as furnaces, flues, chimneys, ramps, or cranes, building and auxiliary equipment, would undoubtedly result in lower total bids. Guarantees should be incorporated, rigid but not unreasonable. Such guarantees should suit the purchaser and not be drawn by the promoter to fit his own product."

The patent situation "has resulted in contracts for numerous plants in their entirety, when only certain details of the furnace construction were involved in the patent. It should be possible to strike a happy medium, so that the engineer or other official who is entrusted with the preparation of specifications would be able to provide for various types of patented furnaces, yet require that all detail of construction and performance guarantees be placed on a comparable basis. The city should derive the benefit of maximum competition; yet, in fairness to bidders, all designs submitted should be on a readily comparable basis. The furnace proper should be accorded only so much importance as is deserved."

The report contained tabulated data from 74 cities, obtained by means of a questionnaire, classified under 23 heads.

Many reported considerable increase in amount of garbage in the "summer," "late summer," or "canning season." Wrapping of garbage was reported by Aberdeen, S. D., Allentown, Pa., Binghamton, N. Y., Buffalo, N. Y., Grand Forks, N. D., Minneapolis, Minn., New Bedford, Mass., Pasadena, Cal., Portland, Ore., Sioux City, Ia., Tuscon, Ariz., Utica, N. Y., and Ottawa, Ont.

Average lengths of haul to disposal points varied from ¾ mile to 19 miles, but with only six less than 1½ miles, seven more than 6 miles.

Final delivery was made in the same vehicles as collection in 50 cases and partially in 5 more. Final delivery was made by trailers and tractors in ten cities; by large trucks in ten cities; by rail in seven cities; by scow in four; two of these methods being employed in some cities.

The reported costs of collecting garbage and carrying it to point of disposal varied from $1.14 to $6.19, only 47 giving figures per cu. yd. or ton.

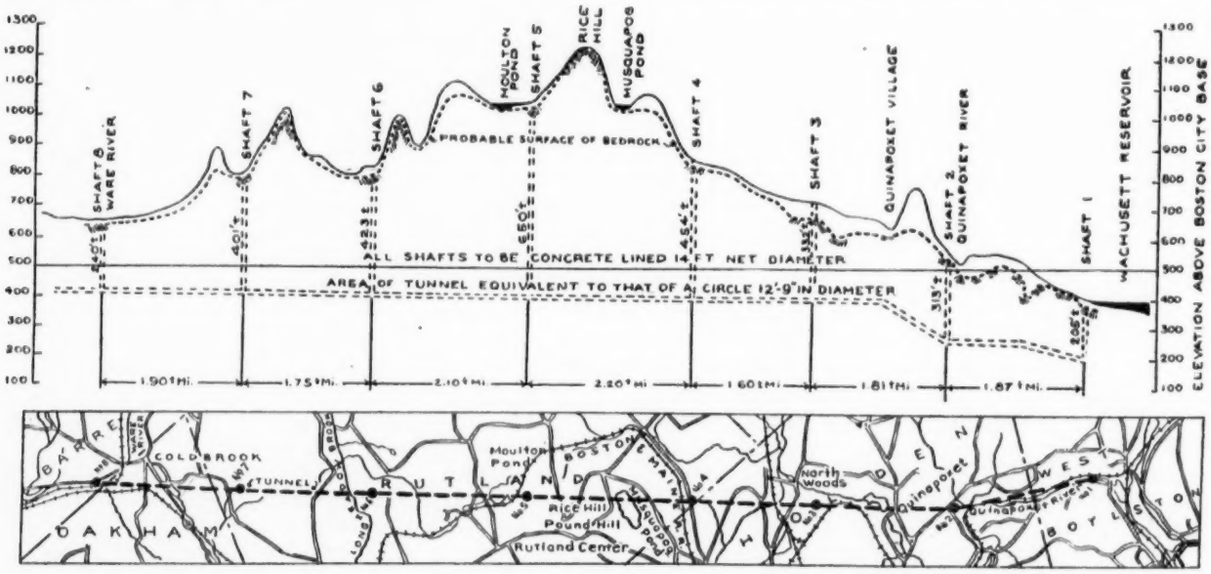
Disposal by incineration was reported by 16, with 6 others disposing of part by this means. Reduction was reported by 8, with 3 others disposing of part by this means. Hog feeding was reported by 21, with 11 others disposing of part by this means. Dumping, land fill or plowing in was reported by 10, with 13 disposing of part by this means. Burning in the open and preparation of stock food product were reported by one city each.

The report contains a list of 79 Decarie incinerators, 5 built in 1927; 20 "U. S. Standard" incinerators, 12 built in 1927; 50 "Superior" incinerators, 7 built in 1927; 70 Nye "Odorless" incinerators, 10 built in 1927; and 13 "Sterling" incinerators, 6 built in 1927. Also 7 reduction plants constructed by William G. Morrison Co., and 6 by C. O. Bartlett-Snow Co., none built last year.

New Boston Water Tunnel

Construction work under way on shafts of thirteen-mile tunnel to bring water from Ware river to Wachusett reservoir.

Contracts have been let and work is now being prosecuted on the shafts for the 13-mile tunnel of the new water supply for the Boston Metropolitan district, which tunnel is to extend from the Wachusett reservoir to the Ware river in Coldbrook. Ac-

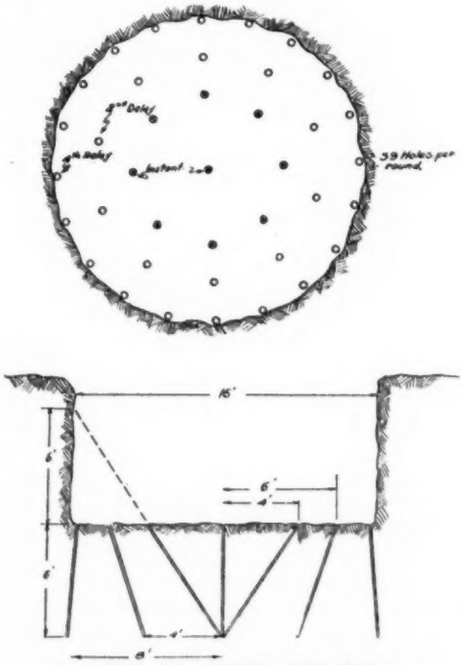


PLAN AND PROFILE OF THIRTEEN-MILE WACHUSETT-COLDBROOK TUNNEL

tual construction work on this project has come at the end of several years of discussion as to the best method of increasing the supply of the Metropolitan district. In 1922 what was known as the joint board was appointed and the following year it recommended building a large storage reservoir on Swift river for holding the flood waters of that river and of Ware river. This was opposed by manufacturers and cities in the central portion of the state, where the Swift and Ware rivers form important sources of supply. In 1924 another investigating commission was appointed and its report in 1925 recommended the use of other supplies nearer at hand. (A synopsis of this report was given in our issue of January, 1926.) The presentation of the latter report was followed by discussions by engineers, politicians, business men, and others interested in the subject, and the former recommendation, for using the Swift and Ware rivers, with some modifications, was finally adopted. The Massachusetts Metropolitan District Water Supply Commission has now started on the construction of this project, which it is expected will not be completed before 1944.

The project is divided into two main subdivisions, the first consisting of 13 miles of tunnel extending from the Wachusett reservoir to the Ware river. The tunnel will have an area equivalent to that of a circle of 12 feet 9 inches diameter. Six of the shafts will be solely for construction purposes, but shaft No. 1, at the Wachusett reservoir, will be maintained to discharge water from the tunnel into the reservoir, while shaft No. 8 will serve as an inlet from the Ware river.

The second section consists of 12 miles of tunnel extending westward from shaft No. 8 to the Swift river, which will be dammed to form a reservoir 18 miles long and with 35 square miles area and receiving the run-off from 186 square miles. This



TUNNEL HEADING, SHOWING ARRANGEMENT OF DRILL HOLES

reservoir will be used to store not only the water of the Swift river, but also that of the Ware river when it is desired to store it here rather than in the Wachusett reservoir. The intake level at the Ware river is higher than either the Swift or the Wachusetts reservoirs, and consequently water can be diverted by gravity to either of these and can be drawn by gravity from the Swift reservoir to the Wachusett. In fact, the head between the Swift reservoir and the Wachusett will be such that it is proposed later to install a hydro-electric plant to utilize the unnecessary head available.

Contracts for shafts No. 2, 3, and 4, have been awarded the Dravo Contracting Company of Pittsburgh. Contracts for shafts No. 5, 6, and 7, have been awarded to J. J. Coughlan & Sons, Inc., of Boston.

The method of handling the work on shaft No. 5, is described in the "Explosive Engineer" for December, from which we obtained the following information.

Shaft No. 5 is to be 650 feet deep, 16 feet in diameter in the rough and 14 feet after lining with concrete. The Coughlan bid for this was $140,000, which was the lowest bid.

After passing through 18 feet of clay, the shaft reaches a laminated mica schist which is hard and dense, the laminations being from six inches to about three feet thick. It is desirable to break the rock as far as possible into individual blocks, each one just large enough to be easily lifted by one man, since secondary breaking is expensive, and shovelling up fine material is more expensive in shafts than in tunnel work.

After trying one or two arrangements of drill holes for blasting, the contractor found that the use of 9 cut holes, one reliever ring of 10 holes, and 20 rib holes, or a total of 39 holes, worked exceptionally well, easily breaking the rock to the desired size with a minimum of drilling and consumption of explosives. The drill round used is shown on the accompanying diagram. The depth of drilling was established at 6 feet by the fact that with two ten-hour shifts a day, one complete round can be excavated in that time.

The contractor is using two Sullivan angled compound compressors, each furnishing 510 cubic feet of free air a minute; delivering it to the receiver at 105 pounds pressure. A Lidgerwood 50 h.p. hoist raises the muck in round, side-dump buckets of 24 cubic feet capacity. These dump the muck into small, narrow-gauge iron cars, which are pushed by hand to the dump which at present is only about 100 feet from the shaft. Drilling is done with Sullivan rotators, the drills being sharpened by means of an oil furnace and sharpener located at the shaft collar.

Gas From Stuttgart Sewage

The city of Stuttgart, Germany, collects gas formed by the anaerobic fermentation of the sludge from its sanitary sewage, the gas production averaging about 100,000 to 140,000 cubic feet daily; the population being 350,000. This gas analyzes about 12% to 20% CO_2, 4.8% of H_2, 75.5% of CH_4, and 4.7% of N_2. It has a calorific value of 7,500 to 8,500 calories per cubic meter. The gas is sold to the gas works.

Effect on Cement of Certain Salts in Mixing Water

In many parts of Texas, the only waters available for use in mixing concrete contain relatively large pecentages of soluble salts, the so-called "gyp" and "alkali" waters being frequently encountered. It has generally been considered that the sulphates are the most injurious salts, and tests of such waters usually have consisted in a determination of the effect of the water on mortar strength in comparison with a water of acceptable quality, with occasional tests of total solids and percentage of sulphate ion. However, since it was not known definitely what percentage of sulphates might be expected to be injurious, a chemical analysis furnished little information of value.

An investigation of the effect of various salts in the mixing water on the compressive strength of cement mortars has recently been completed at the University of Texas and the results published in Bulletin No. 2730 by F. E. Giesecke, H. R. Thomas and G. A. Parkinson. To obtain definite quantitative results on the effect of some salts which might be present in mixing waters, a preliminary series of tests was started in 1922. These tests consisted of the determination of the compressive strength of 480 2-by-4-inch cylinders of neat cement mixed to normal consistency, using distilled water with the addition of various percentages of sodium chloride, sodium sulphate, sodium carbonate, magnesium chloride, and magnesium sulphate. These tests were made at ages of 28 days, 3 months, 1 year, and 3 years.

After these tests had been started it was thought advisable to make similar tests on 1:3 (by weight) sand mortars, and to include some salts not used in the preliminary tests. In this series of mortars the following salts were used: Sodium chloride, sodium sulphate, sodium carbonate, magnesium chloride, magnesium sulphate, calcium chloride, and ferrous sulphate. These tests were made on 2-by-4-inch cylinders, which were tested at the same ages as the neat cement.

In each case the amount of salts used was based on desired percentage of negative ion in the mixing water, the concentrations being 0, ½, 1, 2, and 4 per cent.

In the main group of 1:3 mortars consisting of 700 cylinders, the sand used was from the Colorado River at Austin. In another smaller group consisting of 500 cylinders, a natural limestone sand from Burnet County, Tex., having practically the same grading as the Colorado River sand, was used. In this latter group the calcium chloride and ferrous sulphate were omitted.

The results of the various series of tests are given in the report on the investigation and comparisons made on the basis of the ratio of the unit strength at a given age for a given percentage of added salt to the strength for no added salt. They show that all of the sodium salts used are injurious to Portland-cement mortars, the chloride, sulphate, and carbonate showing progressively greater reduction in strength for a given percentage of negative ion. The two magnesium salts used have only slight effect. Calcium chloride and ferrous sulphate are beneficial.

It is quite evident from the results that, so far as mixing water is concerned, the sulphate ion is not necessarily injurious to the strength of Portland-cement mortars. Of the three sulphates used, the sodium salt is injurious, the magnesium salt shows slight effect, and the ferrous sulphate increases the strength materially.

Compared to the percentages of salts used in these tests, the waters from springs, streams, and wells will, in general, contain relatively small percentages of dissolved salts. From a study of the chemical analysis of waters from many parts of this State, it is noted that in the great majority of cases the total solids are less than 5,000 parts per 1,000,000, or about one-half of 1 per cent. Even if all of this amount of salt were sodium carbonate (which was the most injurious of the salts tested) this would correspond to about 0.3 per cent of carbonate ion, which probably would not reduce the mortar strength more than about 5 per cent.

In presenting conclusions as to the results of the tests, attention is called to the fact that the results given apply only to salts present in the mixing water and that all brands of cement may not be affected in the same way. The following conclusions are presented as a general summary of the results obtained.

(1) Sodium salts (chloride, sulphate, and carbonate) are injurious to Portland-cement mortars.

(2) Magnesium chloride and sulphate have very little effect on mortar strength.

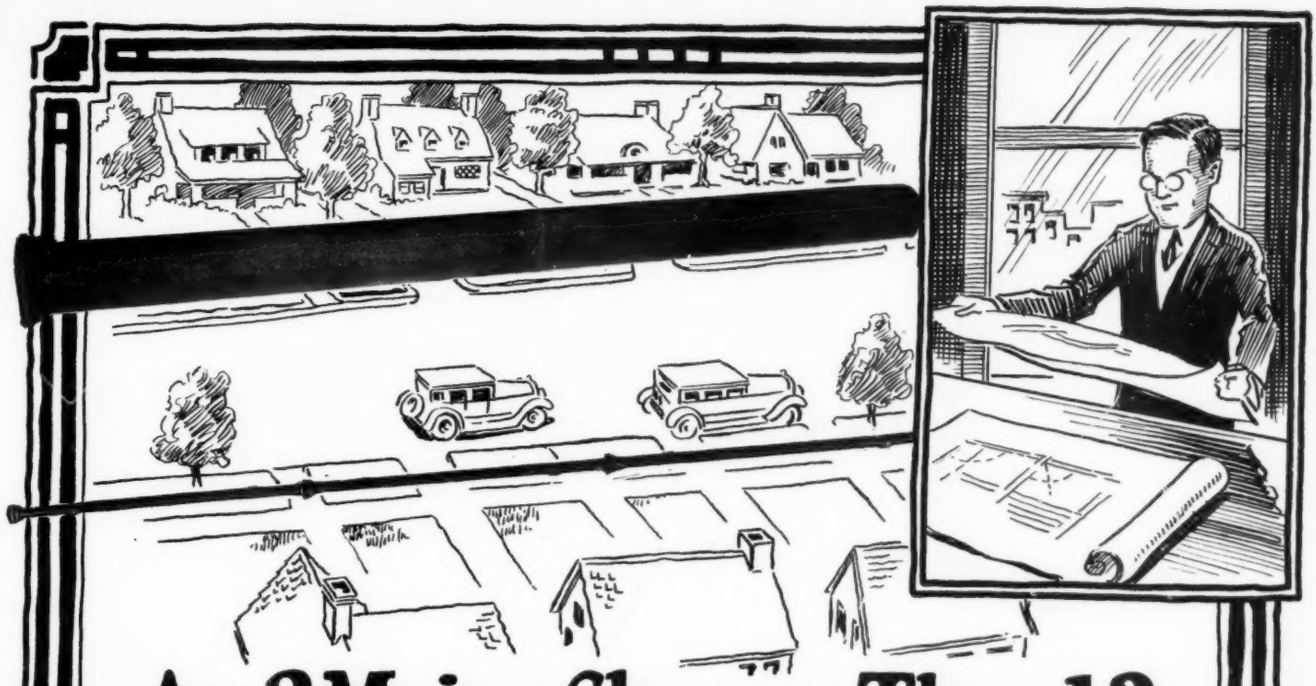
(3) In general, the strength ratios tend to increase with age—that is, for a salt that reduces the strength, the reduction is less for greater ages, and for salt that increases the strength the percentage increase at 3 years is usually greater than at 28 days.

(4) Sulphates are not necessarily injurious to mortar strength.

(5) Two per cent of sulphate ion in the form of ferrous sulphate—that is, about 6 per cent of the salt—increases the mortar strength approximately 20 per cent.

(6) Relatively few natural waters contain high enough percentages of total solids to make them unsafe for use in concrete.

While it is probable that ferrous sulphate will not be present in natural water, it was included in this series in order to determine the effect of an iron salt on the strength of Portland-cement mortar. For some years it has been noted by members of the laboratory staff that natural sands containing finely divided iron oxide seemed to show abnormally high strengths, and it has been the opinion that the iron present might have some chemical reaction with the cement, thus increasing the mortar strength. The results obtained with this salt seem to confirm the opinion. It would be interesting to know the effect of some other iron salts, and it is believed that it would be worth while to extend this part of the investigation to include the effect of various commercially available iron salts on the strength and other properties of Portland-cement mortars and concrete.



Are 2 Mains Cheaper Than 1?

IT IS hard to believe sometimes, but it seems a new idea always must struggle along for awhile

Remember, the duplex-main is intended only for residential streets Down one side of the street lay a McWane pipe line—say 6-inch or 8-inch. On the other side of the street lay a 2-inch McWane pipe. Water works authorities favor a 2-inch secondary main because experience has shown difficulty in obtaining proper circulation through secondary mains of larger size

Cross connect the two mains at each street intersection—use the larger main for fire plugs

The elimination of service lines to a single main in the street, saves more than the cost of the small main of the duplex-system! Installation and maintenance of service lines is simplified—and much less expensive. Cutting and repairing street paving is over

The Duplex-Main, though rather revolutionary, is winning converts—men who keep up with the times by looking for new ideas It sounds funny at first, but it STANDS INVESTIGATION. Write us for details, diagrams and prices We are the largest manufacturers of Two-Inch cast iron pipe in the world.

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INSLEY

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Importance of Weighing Refuse Collections

Comparison of costs of collecting and disposing of garbage in different communities, or by different methods or types of equipment in the same community, is rendered difficult or impossible in most cities by the absence of reliable figures for the weights of the collections. Most of the quantities and costs found in reports and textbooks treating of refuse are probably erroneous for this reason. There can be no science of refuse disposal until we have reliable data upon which to base it.

How much garbage per day per family can be used as the basis of planning for collection or disposal in a city in a given latitude? How many collection vehicles of any assumed type should be necessary to collect it under given conditions of density of population, street grades and pavement conditions? How much refuse of a given composition can be burned per day under service conditions by any given type of incinerator? Is the present administration performing the collection and disposal services more economically than its predecessor? None of these can be answered without knowing the amount of garbage or other refuse collected; and to answer most of them requires knowledge of the weight of each load, by what vehicle collected, from what area, and when delivered at the dump, incinerator or other destination.

A number of cities estimate quantities or weights by measuring the capacity of collection wagons and obtaining the weight of a level load once or twice a year, and (theoretically, but how often practically?) having a careful estimate made by a competent man of the percentage each load is of the level load used as a basis. Such information is better than no data, but too many human frailties and equations are involved to justify placing much confidence in it.

Weighing is impracticable—it would cost too much, is the common reply to such arguments. We believe that a proper system of records would result in cutting collection costs from ten to fifty per cent in almost any city. This would result from both a better planning of collection districts made possible by such information, and less loafing by collectors if they know that the superintendent will learn what time was consumed by each man in each collection trip and the amount collected. More or less reliable figures from several cities indicate that the average cost of collection is about 50 cents to $1 per capita per year. In a city of 30,000 population this might amount to $25,000. A timekeeper who weighed and timed each vehicle as it reached its destination would, if he did nothing else, earn a salary of $2,500 a year if he effected a saving of only ten per cent.

If engineers and superintendents would only realize the importance of this information they would find a way to get it. Let us assume a platform scales just outside or inside a disposal plant or dumpground entrance. It has a self-registering attachment and carries a time clock, both actuated by the same handle. The driver brings his loaded wagon onto the scales, descends (and so is not weighed with the load) and pulls this handle. This registers the weight and the time, with no possibility of error, careless or intentional. The time clock he sets to register also his own wagon number—if he does not he does not get credit for this or any other load during this collection period. The empty weight of the wagon is known. No extra weigh man is required, only the collection of the record once a day. The only cost is interest, depreciation and repairs on the weighing and recording apparatus.

To forestall a flood of inquiries, we will confess that we know of no such registering equipment. On the other hand, we think any mechanical engineer will admit that there would be no difficulty and little expense involved in designing such equipment.

Probably more than $15,000,000 a year is spent in collecting refuse; and we believe it would be possible to cut the collection cost by at least a third by means of a scientific study based upon reliable and reasonably accurate data, which do not now exist.

Prevalence of Typhoid Fever in the United States

Preliminary reports from the health officers of 36 states for 50 weeks of 1927 show that the incidence of typhoid fever during 1927 was less than it was during the two preceding years. For 50 weeks in 1925, these states reported 30,700 cases; in 1926, 25,600 cases; and in 1927, 22,400 cases. Their aggregate population is about 88,000,000.

The typhoid fever death rate in the registration area of the United States dropped from 35.9 per 100,000 population in 1900 to 6.5 in 1926.

Garbage Collection in Omaha

In Omaha, Nebraska, with a population of about 225,000, and an area of about 36 square miles from which collections are made, the garbage is collected separately from the other refuse by a contractor and is carried by him a distance of about thirteen miles from the center of collection to a farm, where it is fed to hogs. It is collected daily in the business district and from once to twice a week in the residence district. The contractor receives $87,500 a year for collecting and disposing of the garbage, or about 38 cents per capita per year.

Since it would be uneconomical to transport the garbage the thirteen miles to the farm in the small vehicles in which it is collected, the contractor has worked out a plan as follows: He had an automobile body building concern manufacture for him 45 steel tank bodies, each carrying a small steel wheel under each corner. One of these bodies is placed upon the chassis of a one-ton truck, and is then filled by the collector in his regular rounds. When filled it is driven to a central station, where it is rolled off of the rear of the chassis onto a platform which is at the same elevation, following which the driver of the collecting truck goes to an adjacent platform where an empty tank is rolled onto the chassis. At intervals, one of three 5-ton trucks, which are used to haul the garbage from the loading station to the farm, draws alongside of that portion of the platform which receives the loaded tanks, when four of these tanks are rolled onto the chassis of the large truck and hauled to the country; the 5-ton truck having first rolled off the empty tanks it has returned onto that part of the platform reserved for these. The wheels on the tanks permit rolling them quickly and easily from chassis to platform and from platform to chassis, thus saving considerable time and doing away with the necessity for a crane or any similar contrivance.

Arriving at the hog farm, the garbage is shoveled out by hand. There are no bolts, rivets or other obstructions inside of the tank to interfere with the shoveling. After the tank has been emptied it is washed out thoroughly and returned to the loading station. The exchange of full and empty tanks is made at the farm in the same way as at the loading station in Omaha.

Besides speed and convenience in transferring from small trucks to large trucks, these steel tanks, being thoroughly cleaned out before any of the contents begins to spoil, insure getting the garbage to the hogs without spoiling, which is a very important matter in hog farming.

Water Waste Elimination in Chicago

Universal metering in two selected districts reduces waste 350 gallons per capita per day. Underground leakage of more than a half-million gallons stopped. Pitometer survey procedure.

At the beginning of the year 1927 the city of Chicago had in service 57,532 meters, of which 14,851 had been installed during the previous year. This gave 14.84 per cent of all services metered. This included most of the large consumers and 31.7 per cent of the consumption of the city was metered. In spite of this, however, the consumption per capita was 285½ gallons or 2,264 per tap.

In view of this high consumption of water, efforts have been made to reduce the waste and leakage. Special tests in advance of street paving were made, hydrants, valves, water mains, and services in a street up to and including the stopcock at the curb being inspected and tested for leakage and any leaks indicated being located and stopped. During 1926 careful leakage tests were made on 66.13 miles of pipe in streets which were up for paving; previous to which an inspection of the service pipes was made and any services not required were recommended to be cut off. This tests showed a total leakage of 658,862 gallons per day, of which 600,324 gallons were stopped. During the 11 years previous to 1927, 668 miles of main had been tested,

or 20 per cent of the total mileage in service, and a leakage of 8,841,328 gallons per day was discovered. If the rest of the system was in the same condition, this indicates a leakage of 44,000,000 gallons per day or 4.9 per cent of the average daily pumpage.

An ordinance providing for universal metering was passed in September, 1925, (to conform to conditions made by the Federal government; now being repudiated by the present mayor). Universal metering was begun in those sections where waste was most serious. One of these was in the southeastern corner of the city where there was an average daily per capita consumption of 402 gallons. Could the waste and leakage in this section be considerably reduced, it would postpone indefinitely the construction of a 36-inch feeder main estimated to cost about a quarter of a million dollars. Another section of the city known as Hegewisch and two communities outside the city limits were supplied through feeder mains approximately 11 miles long, and decrease in consumption would allow a reduction in pressure at the pumping station which supplies them. As a matter of fact, at the close of the year when this territory was approximately 100 per cent metered, there was an increase in pressure of about 10 pounds throughout the entire territory. Pitometer surveys made previous to metering and at the ending of the year showed that in the Hegewisch district the consumption per capita per day before metering had been 445 gallons and after metering 103 gallons, while a further reduction of 53 gallons would be possible by eliminating plumbing waste and underground leakage which had been located but not stopped. This meant a saving per capita per day of 352 gallons of waste.

In the southeastern territory referred to the consumption before metering was 402 gallons per capita per day and after metering 194 gallons and it was estimated that a further reduction of 94 gallons was possible by eliminating plumbing waste and underground leakage.

A study of the consumption in the Hegewisch district indicated that before metering it consisted of eight gallons per capita underground leakage, 361 gallons plumbing leakage and wilful waste, 45 gallons legitimate domestic usage, 31 gallons industrial usage metered, and 10 gallons public and unaccounted for. The last three items were considered to be unchanged after metering, while the plumbing leakage and wilful waste was reduced to 15 gallons and underground leakage to 2 gallons.

"One very striking example of reduction in domestic water consumption due to installation of meters," said the Bureau of Engineering in its annual report, "was found in Hoxie avenue from 107th street to 109th street. In this street it was discovered that water was flowing day and night at practically an even rate of flow amounting to 1100 gallons per day per capita. After meters had been set on all of the services in these two blocks, a total of 51, an intensive inspection was made to determine the condition of the plumbing in each house. This inspection was carried on through a period of seven months.. and showed that the effect of metering has been to reduce the average daily per capita rate from 1100 to 45 gallons.... The plumbing in this section is for the greater part of the old type plumbing and quite old. . . . When the first pitometer survey in this street was made there were about 13 hopper closets in 51 premises. A test was made to determine whether or not these hopper closets were responsible for the great amount of water wasted in this street. It was found that the premises which had hopper closets accounted for approximately 100,000 gallons per day of the consumption. However, it was found that other types of closets when not kept in repair were almost as wasteful as the old type hopper closets when left running continuously."

The total amount of water saved during 1926 due to meterization and stoppage of underground leakage was more than 10,000,000 gallons per day and the cost of pumping this amount of water at $35 per million gallons is $127,750 per year.

In order to eliminate as far as possible the underground leakage in street mains and services, an assistant engineer of the department, William B. Weldon, was placed in charge of "pitometer surveys and underground leakage investigations in connection with metering." He was instructed to "originate a plan and an organization to put it into operation so that the pitometer surveys and work to locate and stop underground leakage would be carried on to keep pace with the meter installation."

One party was working by March 1, 1926, and the second by March 16, and the third by September 1. Each field party consisted of one junior engineer, two rodmen, two laborers, and a truck with a chauffeur. In general the work was handled as follows: Before any work was done on metering, a survey was made of a district which, in general, is one-fourth of a section, to obtain the rate of consumption throughout the 24 hours. After meters had been completely installed, each section of main was tested for leakage and if leakage was indicated it was located by the use of engineering instruments. After all leaks in a district had been located an order was issued to the water pipe extension district forces to repair them. When the leaks had been repaired the mains were again tested and the procedure repeated until all leaks had been eliminated. A resurvey was then run of the whole district to determine the consumption after metering and stoppage of leaks. When pitometer surveys had been made within the preceding three or four years, an advance pitometer survey was considered unnecessary. No considerable amount of time was spent in locating and stopping leaks of less than 1,000 gallons per day, as the benefit obtained therefrom was not considered worth the expense involved.

Experience has indicated that the service pipe is the greatest source of leakage. Valves in the territories surveyed were in exceptionally bad condition. Many were found leaking which were not recorded in the measurements, as the leaks stopped when the valves were closed for testing. However, they were ordered repaired without any credit for leakage stops. Many valves were found which it was difficult to operate, but all valves were operated and are now in better condition.

Of the underground leakage discovered during the eleven years, 1,867,716 leaks were at joints,

943,584 were broken pipe, 4,310,455 were service pipes, 933,213 were hydrants, and 104,597 were valves.

Automatic Sewage Flow Control

Motor-controlled sluice gate diverts flow from tributary to outfall sewer when flow in either reaches a predetermined amount.

There has recently gone into operation in England a project which includes interesting features provided for controlling the flow from one sewer into another. The sewage of Leyton had formerly been treated in a local sewage treatment plant, but arrangements were made for discharging it into the main drainage system of London instead, the connecting pipe leaving the Leyton outfall sewer near the old treatment plant. According to the agreement under which this was brought about, when through any cause the water level in the London County Council sewer shall rise to a level 8½ feet above ordnance datum, discharge into it of the Leyton sewage shall be automatically shut off by means of a sluice valve at the Leyton sewage disposal works. Also when the rate of flow from Leyton shall exceed a certain specified amount (equivalent to 50 gallons per day per head of an estimated population) the flow shall be automatically regulated at the Leyton end.

In order to fulfill the first of these conditions, a motor controlled sluice valve was installed in a meter house adjoining the sewage disposal works and electrically connected with a float chamber at the junction of the Leyton sewer with the London County Council sewer. When the float rises to 8½ feet above datum, contact is automatically made and the circuit completed, when a bell is rung and a warning light exhibited in the meter chamber at Leyton, while at the same time the sluice valve is automatically shut down. When the flood level at the junction falls to 6 feet above datum, warning is again given by means of a light and bell in the meter house and the sluice valve can then be released by actuating the motor from the meter house.

The rate of flow in the Leyton sewer is recorded on a chart attached to the drum of a venturi meter through the which the sewage flows, to which is also connected the usual counter indicating the aggregate flow. The apparatus is so arranged that when the pen on the chart, whose vertical component represents the rate of flow, rises above a certain line, the sluice valve is automatically regulated to prevent that maximum rate being exceeded, at the same time ringing a warning bell and illuminating a second signal lamp.

When the Leyton sewage is prevented from flowing into the London sewer by the rise in that sewer, or the rate of discharge into the London sewer is diminished because it exceeds a certain maximum, the excluded sewage flows into one or more of seven rectangular settling tanks and two circular settling tanks having a combined capacity of over two and a quarter million gallons, which were part of the old Leyton sewage treatment plant and are maintained as a standby for storage purposes.

Records for several years past indicate that the number of times the water level in the London sewer rose to 8½ feet above datum averaged only eight per year, and the total time during which it remained above 6 feet was only about 14 hours per year. It is therefore highly improbable that the amount of sewage which will be diverted to storage exceeds the capacity of the old treatment plant; but should it do so, it would be when the Leyton sewage is highly diluted and the excess could be turned as storm water into an adjoining brook. The sewage diverted for storage into the old plant flows back into the London sewer on the reopening of the sluice. It has been found so far that there is very little sedimentation of sludge in the tank while it is holding the overflow.

Reservoir Dam of Permeable Material

Forty-eight feet high, composed of quartz sand with very small percentage of silt and loam, resting on ninety feet of similar materials. Design and construction.

In connection with increasing the water supply of the city of Chicopee, Mass., an impounding dam was built which, because it was built of permeable material and resting upon permeable soil, is of unusual interest. It was described in a paper before the New England Water Works Association by Myron G. Mansfield, of Morris Knowles, Inc., engineers, which firm had charge of the designing and construction of the work.

There was already a small reservoir on Cooley brook, with a capacity of about 3,000,000 gallons, and it was decided to build a higher dam, impounding 135,000,000 gallons, to be located near the upper end of the existing basin. The new reservoir has a water surface elevation of 170, which is 40 feet above that of the old reservoir.

Investigation of the site showed that the underlying strata to a depth of approximately 90 feet consisted of gravel, sand, and silt, some of which are quite pervious; rock being found at 90 feet. In investigating the character of the soil, seven test pits were excavated between the flow line and the bottom of the valley, with depths ranging from 3 feet to 17½ feet; and five test holes with a maximum depth of 91 feet were drilled from the bottom of the test pits. Also two auger borings, one on each slope, were made to a depth of 30 feet, at an elevation of about 40 feet above the proposed flow line. Samples thus secured were analyzed and reported upon by Dr. Charles Terzaghi, Professor of Soil Mechanics in the Massachusetts Institute of Technology; the chief object of this being to establish a basis for estimating the expected loss of water due to percolation around and under

the proposed structure and for judging the suitability of the materials available for the embankment. Complete mechanical analyses and determinations of the voids in a loose and in a compacted state were made of all samples obtained from the test pits and test borings. Also permeability tests were made upon six typical samples selected from those obtained from the test pits.

"The outstanding features of the materials forming the underground strata at the dam site are the exceptionally low uniformity coefficients and the almost complete absence of clay. The uniformity coefficients range between 1.72 and approximately 4. The materials consist essentially of quartz grains intermingled with some light and dark mica. The effective size of most of the samples ranged between the limits of 0.02 and 0.06 m.m.

"Considering the character of the underground strata and of the materials available for the embankment, a core wall type of dam combined with a cut-off consisting of steel sheet piling seemed to present the most satisfactory solution of the problem; the core wall to prevent the loss of water through the embankment, and the sheet piling to reduce to a minimum the seepage of water underneath the dam."

The embankment is approximately 550 feet long at the top, with a maximum height above the bed of the stream of approximately 48 feet. It is composed almost entirely of sand with a very small percentage of silt and loam. A reinforced concrete core wall 12 inches thick, with double reinforcement, extends the entire length of the embankment and projects beyond the ends into the adjacent hillsides approximately 25 feet, and extends two feet above the top of the down stream side of the embankment and four feet above the top of the upstream side.

The embankment top is 15 feet wide down-stream from the core wall and 6 feet wide up-stream. The down-stream slope is 2½ to 1, with a 5-foot berm at elevation 152. The up-stream embankment has a 3 to 1 slope with a 5-foot berm at elevation 156.

A continuous row of steel sheet piles 30 feet long was driven for the full length of the dam, these being directly under the center of the core wall. In the top of each sheet pile was drilled three holes about 6 inches apart vertically in which were placed half-inch steel bars which were embedded in the base of the core wall, which base is 2 feet 6 inches wide and 24 inches high.

Due to the physical characteristics of the materials used for the embankment, there was danger that they might flow whenever the state of saturation combined with an hydraulic gradient directed toward a free surface, which conditions are apt to occur in the up-stream part of the embankment when the water level in the reservoir is being lowered rapidly, and in the down-stream section due to water seeping beneath the dam into this part of the embankment. The first was perhaps the more serious due to the necessity of using the least permeable material available for the up-stream section. For this reason, the slope of the up-stream side was made 3 to 1 and above the berm was protected with a concrete pavement 6 inches thick, underneath which was placed a graded filter consisting of 6

CHICOPEE DAM, CONCRETE PAVING ON LEFT SIDE. CORE WALL PROJECTING 4 FT. ABOVE PAVING

inches of gravel or broken stone and 6 inches of coarse sand. At the berm was a concrete beam 21 inches wide and 3 feet deep, through which were carried 6-inch weep holes at regular intervals, through which the seepage water could escape from the coarse material under the slab. The paving slabs were made approximately 20 feet square, reinforced with wire mesh. Below the berm the slope was protected with a layer of gravel and broken stone 18 inches thick at the berm and 60 inches at the toe.

The down-stream embankment was intended to be permeable and was therefore made of coarser sand, with an effective size of 0.2 mm., while the upstream embankment was made of material with an effective size of .02 mm.

Prior to placing any of the embankment, the black muck in the bottom of the valley within the embankment area was removed to a maximum depth of 4 to 5 feet.

The weakest point in the entire project is the extent of seepage which is expected to occur around the wings of the dam at full reservoir, through the pervious strata in the soil. "These losses may amount to as much as 180,000 gallons per day; but, due to the geological character of the strata located on both sides of the dam, there was no chance for appreciably reducing these losses by extending the row of sheet piles into the hillsides. There is, however, the possibility that the losses due to seepage will gradually decrease by silting up of the valley slopes."

Excavation for the core wall was made with a "Caterpillar" dragline. As soon as sufficient trench had been completed, driving of the steel sheet pile cut-off wall was started, the piles being driven with a steam hammer supported from a cable which spanned the valley over the center line of the embankment; which cable was also used for handling piles, forms and concrete. The core wall was then built in 50-foot sections, approximately 12 feet high. When a course of core wall had been built and set, the embankment was carried up on each side, the heights of embankment on the two sides of the core wall being kept practically the same. The material was placed by means of four "Caterpillar trucks loaded at the borrow pits by a steam shovel. The length of haul was comparatively short. Two 8-hour shifts were worked in placing the major

portion of the embankment, one shift placing material on the down-stream section and the other on the up-stream section. The embankment materials were placed in 6-inch layers and levelled by scrapers operated by two tractors. It was found unnecessary to roll the embankment material, as the constant passage of the "Caterpillar" trucks and tractors while depositing and levelling the material produced better results than could be secured by a roller. Elevations taken at short intervals during and after the placing of the material showed no appreciable settlement even in the up-stream section after the embankment had become saturated to over one-half its depth.

As the up-stream embankment progressed, the broken stone and gravel protecting layer was placed on the slope below the berm and the water was allowed to rise with the embankment. Also, because of the satisfactory method of placing and consolidating the embankment, the concrete slope paving above the berm was placed approximately six weeks after the completion of the embankment.

In order to insure that the kind of material desired was used on both the up-stream and down-stream embankments, several tests were run in the field each day of the permeability of the materials being obtained from the borrow pits. In making the tests, samples of the material were thoroughly dried on a stove, then placed in tubes of about 1½ inches interior diameter, and compacted in a standard manner, the sample being held in the tube by a fine-mesh brass screen fastened at the bottom. This was lowered into the water in a tank, capillary action caused the water to rise in the sample, and by observing the position of the level of the capillary water after 5, 10, 20, and 30-minute intervals and plotting the data, it was possible to estimate roughly the degree of permeability of the material.

Contract for the work was awarded September 22, 1926 to the Sanders Engineering Company of Portland, Maine. Some of the principal items were 9,500 cubic yards of excavation at $1.25; 346 tons of steel sheet pile cut-off wall at $94 per ton; 64,000 cubic yards of rolled embankment at 80 cents; 1,440 cubic yards of concrete masonry at $25 and 860 cubic yards of concrete masonry at $22; 405,000 pounds of steel reinforcement at 5 cents, and 3,600 yards of gravel and broken stone fill at $2.25. The construction was completed on September 8 of the year following. The construction work was in personal charge of E. T. Sanders, president of the contracting company, while the plans and specifications were prepared and construction work supervised by Morris Knowles, Inc., of Pittsburgh, under the direction of Myron G. Mansfield, with Lyman C. Lovell as resident engineer.

Welding Well Casings

In driving and casing wells, steel pipe is ordinarily used; and where the lengths are joined by sleeves, these form an obstruction to the sinking of the pipe into the ground and are objectionable. This has been avoided in the past by different schemes, one of which was to use two lines of pipe casings, one slightly smaller than the other and placed inside of it in such a way that the joints in the two lines did not come opposite each other.

The advances made in welding offer a means for joining consecutive lengths of steel well casing without the objectionable features in either of these methods. With proper welding of the joints we will have a continuous string of casings which is water tight throughout and is as strong at the joints as elsewhere. In sinking a 24-inch well in Texas, six 5-foot lengths were welded into a 30-foot length on the surface. When a section had been driven until the top was about four feet above the ground another 30-foot length was hoisted into position and clamped to the top of the section already driven and the joint welded. Acetylene for welding was supplied from a low-pressure generator on the job. Three men averaged 58 linear feet of welding per day.

American Road Builders' Convention

Papers and discussions dealing, in separate sessions, with problems and practices of constructors, engineers, and county highway officials, respectively. The irresponsible contractor, snow removal and county maintenance among the leading topics.

At the 19th annual convention of the American Road Builders Association, which was held at Cleveland, O., January 9-13, papers were presented which stressed three general problems of the road industry. Constructors considered problems and practices in the field of road building, emphasizing the necessity for solving equitably the difficulties arising from present contracting methods; engineers paid special attention to the use of highways and to means of handling traffic swiftly and safely; attention was given also to country highway construction and maintenance which, as Public Works has repeatedly pointed out, is now one of the most important features of the highway industry.

CONSTRUCTORS' SESSIONS

Alan Jay Parrish, president of the Illinois Association of Highway and Municipal Contractors, in a paper "False Credit in the Highway Industry," pointed out some of the unwholesome conditions still remaining in the industry. He declared that there is a small group of contractors who, paying only a part of their bills, set the figures for the entire field. This group, financed by bankers to an extent sufficient to fulfill the standard questionnaire requirements, pay for their bonds by notes, purchase equipment on credit or by notes, and get their materials by the same methods.

"The average price of all work has been taken at or below the cost of construction," he said. "Following the World War, there was a period of prosperity because of few contractors being in the field. Today many incompetent contractors have flooded

the field. In Illinois we have investigated contractors whose outstanding bills and claims were far in excess of their total possessions."

A. R. Hirst, chief engineer of the American Vibrolithic Corp., Washington, D. C., spoke on "Bonding Practices Which Should be Abolished." He severely criticised "jazz bidders," charging that many irresponsible contractors bid with small reference to actual costs. Among the factors causing unsound practices he listed the attitude of the public which, in general, was based on ignorance of actual conditions; the present lien laws, which make the bonds responsible for payment of all machinery, material and supply bills; the uniform rate laws, which permit a lower rate of premium on a lower bid; and the banks, which encourage undue expansion of small firms, and the establishment of new firms in an already overcrowded field, and which issue certified checks to contractors who do not have sufficient funds on hand. There is too much bidding without a proper reserve of cash, and certified checks worn out with use are presented for compliance with bid bond requirements, he said. He called for concerted action to eliminate these evils.

"Demonstration of Responsibility a Prerequisite for Securing a Highway Contract" was the subject discussed by George F. Schlesinger, director of the Department of Highways and Public Works of Ohio. He said:

The primary objective of competitive bidding is to determine the lowest bidder. Common sense and public good, however, required that the awarding authority should be given some discretion, that in some cases it would be bad public policy to give the contract to the lowest bidder.

The term "lowest and best bidder" seems to be given a somewhat wider meaning by the courts than the term "lowest responsible bidder," although the distinction between the meaning of the two terms is somewhat vague. In determining which of several bids is the lowest and best, you have a right to look to the pecuniary ability of bidders to perform the contract and to their skill, experience, integrity and judgment, and to any other similar consideration affecting their power to carry out a contract.

There would seem to be no question as to the awarding authority's legal rights. However, the fact still remains that basically competitive bidding is predicated on the assumption that the lowest bidder will receive the contract.

Much could be said concerning the qualifications of an ideal, "Grade A," 100 per cent. highway constructor. Without attempting to draw up detailed specifications for such a man, he should possess the following attributes:

Character—That a good character is the best asset a person can possess is true in the highway contracting industry as well as in any other line of business endeavor.

Financial Resources—It is essential that the contractor have sufficient bank balance at all times so that bills may be paid promptly, discounts taken, modern equipment used and labor pay rolls met on time.

Experience in the particular kind and size of work on which the contractor is bidding is highly desirable, although not as assential as the first two qualifications.

Personal Ability—This general term is used to express those qualities of mind and body that are desirable in an ideal contractor. Intelligence that will enable the contractor to understand the reasons for the requirements of the specications, with enough technical knowledge to interpret plans, will prevent many a controversy with the engineer.

About three years ago the Department of Highways of Ohio decided to require contractors bidding on highway improvement projects to submit with their bids a statement of their experience and financial qualifications.

Standard questionnaires are being used in the following states: New Mexico, Florida, Pennsylvania, Ohio, Kentucky, Wisconsin, Missouri, Georgia, Nebraska, Iowa, Delaware and Illinois. Counties, municipalities, the federal government and private consulting engineers also are using the standard questionnaires approved and recommended by the joint conference on construction practices.

Until 1925 a bidding bond was permitted in Ohio, but the Legislature at that time enacted a law requiring that bidders on state road contracts be required to furnish certified checks with their bids. This law has been of great benefit in curtailing the undesirable bidder as, formerly, many bond agents distributed bidding bonds about as freely as their business cards.

During the present administration of the Department of Highways in Ohio, from August, 1925, to December, 1927, 34 contracts amounting to $1,298,423.76 have been awarded to other than the lowest bidder. This constitutes 6 per cent. of the total number of contracts awarded in that period.

W. R. Creighton, president, Foster & Creighton, contractors, Nashville, Tenn., in a discussion of the same subject gave some interesting figures on the amount of cash required to carry on a highway job. From an analysis of a concrete highway job performed last year by his company, he estimated that 10 per cent. of the total cost of work should be available in quick assets, and there should be, in addition, a satisfactory line of bank credit. These conditions presuppose equipment to be paid for.

In the discussion following this paper, there were many comments on the ease with which contractors break into the field, and the subsequent effect on prices. It was stated that 60 per cent. of these fail during their first year.

An interesting discussion on depreciation of road contractors' equipment was led by W. R. Smith, president of the Lane Construction Corporation, Meriden, Conn. He pointed out that the investment in road contractors' equipment has grown amazingly in the last several years, largely due to changed ideas of the engineer. He expressed the belief that a definite policy on depreciation can soon be reached and that it will bring with it the solution of this problem. He urged an intensive study of depreciation factors.

The question, "What Can Organization Do for the Contractor?" was discussed by A. H. Hunter, engineer of the Illinois Association of Highway and Municipal Contractors. He urged a study of depreciation and said that it is the duty of the organization to support the demands and requirements of public engineers for better engineering structures.

The final talk on the Constructors' program was given by H. H. Wilson, managing partner of Winston Brothers Co. & H. H. Wilson, as well as vice president of The Associated General Contractors of America, Inc. He spoke on "The Pernicious Triplets of Construction."

ENGINEERS' SESSIONS

"Measuring Materials for Concrete" was the title of a paper by R. G. Giles, Chief Engineer of Concrete Control, Blaw-Knox Co., which was presented Tuesday afternoon. It evoked considerable discussion of varying nature. Among those presenting their opinions were R. W. Crum, T. H. Cutler, B. W. Davis and W. E. Hall.

The Wednesday afternoon session opened with a paper on snow removal by V. R. Burton, engineer of Research and Statistics, Michigan State Highway Department. He said that, a few years ago the sick dying before medical aid could reach them, babies crying for milk which didn't come, houses burning

down because the fire apparatus could not be driven through the snow, were all favorite themes for securing popular support for a snow removal program.

But it is now recognized that there should be uninterrupted use of highways the year around; and that even in Michigan, with an annual snowfall of 30 to 130 inches, snow removal costs only about 7 per cent. of the entire maintenance cost.

Standardization of methods and equipment and state-wide control have resulted in lower costs.

Two years ago the author, in giving a talk on snow removal, before this association, showed that costs varied with direction of the wind, temperature and topography. At that time it was pointed out that adoption of a plan of center clearing by fast moving vehicles and, as far as possible, the use of heavy tractor units for maintaining storage width, should lead to a considerable reduction in cost. Last year this method was quite generally adopted and this, together with the much better drift prevention measures used, have served to decrease the effect of the drifting factors so that they are not nearly so important as they once seemed.

A further addition of limited amounts of snow fence and the nearly universal adoption of the light patrol clearing and heavy unit widening plan will make costs this winter much more nearly a true reflection of conditions encountered.

In future cost studies it is planned to use the total annual snowfall as a base, with the temperature factor expressed as an average amount of snow remaining on the ground throughout the removal season. Where the snowfall exceeds 50 inches, a marked increase in cost is found.

In a discussion of methods of removal, equipment or costs, certain fundamentals of the class of service to be given must be kept in mind. It is quite generally recognized that about a foot of snow on the roadway effectually blocks the road to motor vehicle use. If continuous service is to be given no more than this amount of snow may be permitted to accumulate.

The first requisite for successful and economical snow removal is adequate drift prevention by means of snow fence, field plowing or wide rights of way with natural cover.

Assuming a five-year life for fence, a foot of movable picket snow fence costs about 6 cents annually for depreciation and interest, erection and dismantling. This makes an annual cost per mile of fence $316.80 for one side of the road only. If we assume a ten-year life of fence, the annual cost per foot is 5 cents and the cost per mile $264.

With equipment at hand for snow removal today, the job requires two operations where snow removal is at all heavy. These two operations consist of first, a patrol operation of fast moving vehicles, keeping the center clear, and second, a widening operation done by the same vehicles as much as possible. It is admitted this method is not ideal, as it involves the handling of some snow twice, but with equipment designed as at present this is most economical.

It is highly important in heavy snow territory to avoid the use of equipment which will ridge the snow. We prefer to plow our snow traps in the adjacent fields and not along our roadways. For this reason some type of rotary is essential. The snow surface left for sleighing in the colder territory is maintained with the ordinary spring scraper designed for gravel floating and slung beneath the plow truck.

This paper was followed by a talk by Homer D. Howard, locomotive engineer, who hauls the "Panama Limited" of the Illinois Central Railroad. Mr. Howard told of the carelessness of automobile drivers and pedestrians as viewed by the man in the engine cab.

COUNTY HIGHWAY OFFICIALS

The meeting of this division occupied both morning and afternoon sessions of Thursday. It was opened by the report of the Committee on Surveys and Planning. Chairman Stanley F. Abel, Kern County, Calif., was not present, and the report was read by E. L. Clemmer, road and bridge engineer of Fayette Co., Pa. W. W. Chadsey, superintendent of highways, Schenectady Co., N. Y., spoke of troubles due to poorly laid out subdivisions and of planning to obviate this difficulty. E. L. Gates, Du Page Co., Ill., reported that he was mapping the entire county on a scale of 100 feet to the inch, a quarter section to the sheet. Where possible, roads have a 200-foot right-of-way, most of the land being donated by the farmers. Pinellas Co., Fla., is making an aerial survey and map.

Chas. E. Grubb, Newcastle Co., Del., reporting for the committee on county highway construction, gave the high lights from 14 counties. Among the interesting items were the ten-million-dollar program of Harris Co., Tex., half of which will be expended in concrete paving, and the six-million-dollar program of Cameron Co., Tex. Mr. Grubb summarized his report by stating there was a definite trend toward better and higher-class construction.

The committee report on County Highway Maintenance was presented by F. B. Wilkes, Maury Co., Tenn. It dealt chiefly with conditions in that county, where about 100 miles of rural road is maintained at a cost of $150 per mile per year by means of motor patrols, using two one-man motor graders and a maintainer pulled by a light tractor. Once a year the roads are scarified and reshaped with a heavy grader. Ditches are cleaned every two or three months by a blade tractor and grader. A report by W. W. Chadsey on "Urban County Highway Maintenance" was followed by a paper on "Improved Service on County Roads by Low-Cost Maintenance" which was presented by C. N. Conner. This paper followed the general lines of a paper by Mr. Conner which is abstracted elsewhere in this issue.

Committee reports on legislation and administration were presented by H. B. Keasbey, Salem Co., N. J., and R. B. Preston, Norfolk Co., Va. Both of these were of interest and value. E. L. Gates, Du Page Co., Ill., gave a long report on "County Road Construction and Maintenance Equipment," which discussed the various types of equipment and their uses. He stressed the necessity for the proper care of equipment and the provision for proper shelter and maintenance. He stated that the use of power equipment was growing rapidly and that, in maintenance, the one-man grader is increasingly important. The county should be the lowest unit for buying equipment, excluding the municipality.

Recent Legal Decisions

RIGHT TO CONDEMN LAND FOR PARKS

Where a village has organized as a park district under sections 4064-4071, North Dakota Compiled Laws, 1913, the board of village trustees has no jurisdiction over the parks of the village, and cannot maintain an action to condemn land for park purposes.—Village of Reeder v. Hanson, North Dakota Supreme Court, 213 N. W. 492.

SALE OF MUNICIPAL LIGHT PLANT AUTHORIZED BY RESOLUTION HELD VALID

The Wisconsin Supreme Court, discussing the legality of the sale by a city of its gas and electric utilities pursuant to resolution, said: "There is much confusion in the authorities in respect to whether municipal legislative action must be in the form of an ordinance, but the weight of authority is to the effect that, where it is not expressly required, a more informal method is sufficient, or the latter is to be given the effect of an ordinance where the exigencies of the particular case do not reasonably require the formal action (State ex rel. Elliot v. Kelly, 154 Wis. 482). The only substantial difference between a resolution and an ordinance apart from the subject to which it shall apply is that the one is required to be published subsequent to its passage and the other is not. Each is subject to veto by the mayor. The words are not infrequently used interchangeably." The sale was held valid.—Wisconsin Gas & Electric Co. v. City of Ft. Atkinson, 213 N. W. 873.

MUNICIPALITY NOT LIABLE FOR ERROR OF JUDGMENT IN PERMITTING STREET RAILWAY TRACK TOO NEAR SIDEWALK

The North Carolina Supreme Court holds, Martin v. City of Greensboro, 192 N. Cor. 572, 137 S. E. 666, that a municipality is not liable for injuries to persons or property resulting from its adoption of a plan permitting a street railway company to build its track so near a sidewalk as to leave insufficient space for an automobile observing the direction to keep to the right to pass between the sidewalk and a car on the track. If the municipality erred, the reasonable inference would be that their error was one of judgment. The exercise of judgment and discretion in the adoption by the municipality of a general plan for the improvement of its streets, the building of its sidewalks and the selection or approval of the space to be occupied by the street railway track is not subject to review by a court or jury in a private action for damages based on the theory that the plan was not wisely chosen; but a private action might be maintained for defective construction of the work, or failure to keep it in repair.

CONTRACTOR'S REMEDY FOR COUNTY'S BREACH OF CONSTRUCTION CONTRACT BY MISREPRESENTATIONS IN PLANS AND SPECIFICATIONS

After a bridge contractor had done considerable work on a contract with a county, for building a bridge over a river, it was discovered that the bridge could not be completed under the plans and specifications prepared by the county's authorized agents and made a part of the contract. The contractors promptly notified the county of this, and the county engaged another contractor to complete the structure. The contractor sued the county on the assumption that the difference between the representations in the plans and specifications as to the facts and conditions under the bed of the river and the actual facts and conditions amounted to a breach of the contract by the county. The Georgia Supreme Court held, Decatur County v. Prayton, Howton & Wood Contracting Co., 137 S. E. 247, that the contractors would not be entitled to recover the entire profits which they would have made if they had completed their contract, but only the value of materials furnished and the work done by them upon the bridge up to the time they abandoned the project, less any amount paid them under the contract.

Georgia Civil Code 1910, §383, declares that every county is a body corporate, with power to sue or be sued. Section 384 declares a county not liable to suit unless made so by statute. It is held that these sections must be construed together and receive a reasonable construction. Under the statute the proper county authorities can contract for the construction of bridges. "Whenever counties are so authorized to contract, and make valid contracts in persuance of such power, they are liable to suits for breaches thereof; in other words, a county can always be sued upon any liability against it created by statute, or for breach of any valid contract which it is authorized by law to make.

MATERIALMAN'S REMEDY—MATERIAL RESOLD TO CONTRACTOR

Material for a public school building was sold to a company which resold it to the building contractors. The contractors had given no surety bond for performance of the contract, as required by North Carolina Compiled Statutes, §2445, as amended. The North Carolina Supreme Court held, A. T. Griffin Mfg. Co. v. Bray, 193 N. Car. 350, that the building contractors were not liable to the seller, although the material was actually used in the building, and the seller could acquire no lien on the building.

SPECIFICATIONS CALLING FOR ALTERNATIVE LUMP SUM BIDS

The New Jersey Supreme Court, in Smith v. Board of Commissioners of Atlantic City, 136 Atl. 607, refused to set aside the award to the lowest bidder of a contract of a heating system for the city's convention hall at the instance of a taxpayer on the sole ground that the specifications invited alternative bids, in the absence of any evidence that they had been unfairly manipulated in favor of the lowest bidders.

A similar ruling was made in Brown v. Atlantic City, 136 Atl. 608. In this case a taxpayer's application for a rule to show cause to review the award

for the provision of alternative bids and a clerical error in the successful bid was disallowed for delay, the application being made nearly two months after the award, during which time the successful bidder had obligated itself on the faith of the award to a large amount.

LIABILITY OF MUNICIPALITY FOR DAMAGE FROM SEWAGE DISPOSAL PLANT

The Washington Supreme Court holds, Southworth v. City of Seattle, 259 Pac. 26, that a city, in the construction and maintenance of a sewage disposal plant on its property is not engaged in a lawful and necessary governmental work on its own premises so as to make the claim for damages to immediately adjacent property damnum absque injuria.

In determining the question of whether the adjacent property had been damaged within the purview of the State Constitution, article 1, section 16, forbidding such damage without first making compensation therefor, the court quoted from Hives v. City of Rocky Mount, 162 N. Car. 409, where the North Carolina Supreme Court, after conceding the rule of nonliability of municipalities for negligence in the performance of governmental duties, said:

"This general principal is subject to the limitation that neither a municipal corporation nor other governmental agency is allowed to establish and maintain a nuisance, causing appreciable damage to the property of a private owner, without being liable for it. To the extent of the damage done to such property, it is regarded and dealt with as a taking or appropriation of the property, and it is well understood that such an interference with the rights of ownership may not be made or authorized except on compensation first made pursuant to the law of the land."

COUNTY COMMISSIONERS NOT LIABLE FOR EXCEEDING APPROPRIATION ON ORDER OF COURT

County Commissioners incurred a liability for road work in excess of the budget appropriation therefor. The parties holding the claims sued the county. The commissioners compromised the action and judgment was entered against the county. A taxpayer sought to hold the commissioners individually liable under section 5 of the Washington Budget Law of 1923. It was held that the provision therein of a penalty against commissioners approving a claim in excess of the budget appropriation is qualified by the exception of such payments on "an order of a court of competent jurisdiction," and the commissioners were not liable.—Porter v. May, Washington Supreme Court, 259 Pac. 34.

CUSTOM TO RECOGNIZE COMMITTEE CHAIRMAN'S AWARD OF EMERGENCY CONTRACTS

The New Jersey Supreme Court, in Grant v. Board of Education of City of Bayonne, 136 Atl. 713, held the board liable to a grading contractor for emergency work done on a bid accepted by the chairman of the board's committee on buildings and repairs, as against the claim that the work was not properly authorized and the charges were unreasonable, where it was shown that the board had previously paid such claims for jobs given to the lowest bidder by the chairman.

MUNICIPALITY LIABILITY FOR DAMAGE BY DRAINS

The Mississippi Supreme Court, Cauthen v. City of Canton, 110 So. 123, holds that where a city uses a natural drain as a drain of the city, but does not cast any waters into the drain except such as naturally flow therein, it is not liable to a property owner for damages to his property from accelerating the flow of water in the drain by reason of its paved streets hastening the flow of the water.

In a suit for damages to property for the negligent construction of a culvert which, it is alleged, caused the water in a drain to become stagnant, filthy, foul-smelling and unwholesome, etc., the proof must show that such condition existed at the time or before the filing of the suit.

CITY BONDS ISSUED FOR SEPARATE PROPOSITIONS

Where a city had ample power to issue bonds for municipal purposes, and no fraud or irregularity in the proceedings therefor is charged, and the city's authority is not exceeded and the bonds have been issued and validated by decree of the circuit court as provided by the State statute, it is too late to plead that the purpose of bonds issued for the purpose of "extending the waterworks and sewerage system" of the city embraces "two or more separate and distinct propositions" and that each proposition was not stated separately.—State ex rel. Wilkes v. Brandon, Florida Supreme Court, 110 So. 127.

CITY'S RIGHTS UNDER INVALID SALE TO IT FOR DELINQUENT TAXES

The Mississippi Supreme Court holds, Hodge Ship Building Co. v. City of Moss Point, 110 So. 227, that a city to which, on a sale for municipal taxes, land is struck off for want of a bidder, is not a "purchaser" thereof to which the statute gives a lien for the amount paid, etc., with the right of enforcement by suit where the sale was illegal.

LANDOWNER'S RIGHT TO APPEAL AGAINST VACATION OF ROAD

A board of county commissioners vacated a road, with the result that a landowner was wholly deprived of access to a portion of his farm. The Kansas Supreme Court holds, Heatherman v. Board of Constructions of Kingman County, 254 Pac. 321, that the fact that the landowner was deprived of his property without compensation and without remedy for compensation, was a legal objection to the vacation, and appeal lay to the district court from the order.

AGREEMENT TO PAY DAMAGE IN USE OF ROAD UNDER CONSTRUCTION

The employes of a pipe line company, authorized to haul and distribute pipe, put it into the ground and connect it up, made an agreement to pay the damage caused by their use of a gravel road under construction, this road being the only one they could use to advantage. It was held, Standard Pipe Line Co. v. Haynie Const. Co., Arkansas Supreme Court, 295 S. W. 49, that this agreement was binding upon the pipe line company, being, if not expressly authorized, easily within the apparent scope of the authority of its agents.

NEWS OF THE SOCIETIES

Feb. 14-16—KANSAS WATER WORKS ASS'N. AND SCHOOL. Lawrence, Kans. E. A. Boyce, Secy., Lawrence, Kans.

Feb. 15-17—ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES. 4th annual convention at Atlantic City, N. J. A. Lee Grover, Secy., Trenton, N. J.

Feb. 21-24—SOUTHWEST ROAD SHOW AND SCHOOL. Wichita, Kansas.

Feb. 28-March 1—AMERICAN CONCRETE INSTITUTE. Annual meeting at Philadelphia, Pa.

March 23-24—NEW JERSEY SEWAGE WORKS ASS'N. Trenton, N. J. John R. Downer, Secretary, Bound Brook, N. J.

April 17-19 — SOUTHEASTERN WATER AND LIGHT ASS'N. Atlanta, Ga. W. F. Stieglitz, Secy., Columbia, S. C.

June 11-16—AMERICAN WATER WORKS ASS'N. Annual meeting at San Francisco, Calif.

June 25-29—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting at Atlantic City, N. J.

ROAD SHOW AND AMERICAN ROAD BUILDERS' ASSOCIATION

The 19th annual road show and convention of the American Road Builders' Association was held at Cleveland, O., January 9-13. There was a very large attendance of contractors and engineers, both at the business sessions and in the exhibit hall.

The convention program was opened Tuesday morning by George F. Schlesinger, representing Gov. A. V. Donahey of Ohio. There followed the official address of welcome by Mayor John D. Marshall of Cleveland. In his response, President Babcock outlined the advances in road construction and maintenance during the past 25 years, and traced the growth of the road show. There followed an address by James H. MacDonald, a report by Charles M. Upham, business director, in which he stressed the need for stricter licensing and examination of drivers, and an address by J. H. Brown regarding the practical application of highway safety.

Separate sessions were held Tuesday afternoon by the constructors and the engineers. General R. C. Marshall, general manager of the Associated General Contractors, and W. H. Root, maintenance engineer of the Iowa Highway Commission, presided at these sessions.

At a luncheon Tuesday, plans were discussed for the formation of a city officials' division of the Association. A number of speakers favored the creation of this division, among them R. K. Compton, A. H. Blanchard, E. A. David, Houston, Tex., and C. B. Hunt, engineer of Washington, D. C. Resolutions were passed sponsoring such an organization, which will be created in the near future.

Wednesday forenoon was given over to the Pan-American session. Delegates were present from a number of Central and South American countries. Dr. E. Gil Borges was not present, and William A. Reid, Foreign Trade Adviser of the Pan-American Union, presided. Among the speakers at this session were A. Madrazo, National Highway Commission of Mexico; Julio Garcia, National Highway Commission of Mexico; M. D. Williams, of Alaska; and Julio Fajardo, Colombia.

At the luncheon held following the Pan-American session, resolutions were adopted to form a Pan-American section of the Association, and early steps will be taken leading to the organization of this section.

In the afternoon, constructors and engineers again held separate sessions with S. M. Williams and Frank T. Sheets presiding. The annual Roadbuilders' banquet was held Wednesday. A feature of this was the ceremony in honor of James H. MacDonald, and the presentation to Mr. MacDonald of $1,000 in gold. The speakers included Mayor Marshall and W. R. Hopkins, city manager of Cleveland.

Thursday was county officials day, and both forenoon and afternoon sessions were given over to this business. A number of interesting and valuable reports and papers were presented, abstracts of some of which will be found on another page. The general sessions of the convention ended Thursday.

The Highway Industries Association, as a result of action taken at the annual meeting, became the Manufacturers' Division of the A. R. B. A. Officers of this division were elected as follows: President, Leon Gardiner, Lakewood Engineering Co., vice-president, Chester H. Lehman, Blaw-Knox Co.; secretary, R. H. Hume; treasurer, W. R. Karll, Le Roi Co.

R. Keith Compton, director of public works, Richmond, Va., was elected president. Vice-presidents are: W. A. Van Duzer, Pennsylvania Highway Department, Harrisburg, Northeastern district; D. B. Dimick, American Castings Co., Birmingham, Ala., Southern district; S. F. Beatty, Austin-Western Road Machinery Co., Chicago, Central district; Samuel Hill, Seattle, Wash., Western district;. James H. MacDonald, New Haven, Conn., was reelected treasurer.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The 75th annual meeting of the American Society of Civil Engineers was held at the society headquarters, New York City, Jan. 18-20. Attention was given to measures looking to the expansion of the technical activities of the society, and the president authorized to appoint a committee to study and report on this.

The board of directors fixed future meetings of the society as follows: 1928, Spring, Washington, D. C.; Annual Convention, Buffalo, N. Y.; Fall, San Diego, Calif.; 1929, Spring, Dallas, Texas; Annual Convention, Milwaukee, Wis.; Fall, Boston, Mass. Dates tentatively fixed: 1930, Spring, Sacramento, Calif.; Annual Convention, Toronto, Ont.; Fall, St. Louis, Mo.; 1931, Spring,

Florida; Annual Convention, Rochester, N. Y.; Fall, French Lick, Ind.

Prizes were awarded as follows: The Norman Medal, B. F. Jakobson, Los Angeles; the James J. Croes Medal, H. C. Ripley, Detroit; Thomas Fitch Rowland prize, L. S. Stiles; James Laurie prize, John R. Baylis, Chicago; Arthur M. Wellington prize, John A. Miller, New York; Collingwood prize, William Breuer, Philadelphia; Rudolph Hering Medal, Harrison P. Eddy, Boston.

Officers elected for the ensuing year were: President, Lincoln Bush; vice-presidents, George W. Fuller and Louis C. Hill; directors, R. E. Dougherty, Malcolm Pirnie, Harrison P. Eddy, Morris Knowles, James H. Johnston, and F. H. Fowler.

AMERICAN WATER WORKS ASSOCIATION

The next meeting of the Canadian Section will be held at London, Ontario, Canada, March 7th to 9th, 1928. A. U. Sanderson, Filtration Plant, Centre Island, Toronto, Ont., is Secretary.

The next meeting of the Indiana Section will be held at Purdue University, Lafayette, Indiana, March 15th and 16th, 1928. Cecil A. Calvert, 1902 N. New Jersey Street, Indianapolis, Indiana, is Secretary.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The winter meeting of the American Institute of Electrical Engineers will be held in New York City, at the Engineering Societies Building, 33 West 39th St., February 13-17.

NORTHEASTERN SECTION, A. S. C. E.

At the annual meeting of the Northeastern Section of the American Society of Civil Engineers, which was held at Boston, Mass., Jan. 28, the following officers were elected: President, Sturgis H. Thorndike; vice-president, Richard K. Hale; Secretary-treasurer, Charles W. Banks; members of executive committee, John C. Chase and Howard A. Gray.

SOCIETY OF ENGINEERS OF SAN FRANCISCO BAY REGION

The Society of Engineers of the San Francisco Bay District, (formerly a chapter of the A. A. E.), held their regular monthly meeting in the Palace Hotel, San Francisco, on Tuesday evening, January tenth. Officers for the ensuing year were elected as follows: Philip Schuyler, president; Glenn B. Ashcroft, vice-president; Wm. G. Rawles, treasurer; Albert J. Capron, secretary; Hans Graff, director; Albert A. Robish, director.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES

The fourth annual convention of the Association of Highway Officials of the North Atlantic States will be held at Atlantic City, N. J., February 15-17. In addition to the presentation of papers on highway subjects, and discussions, there will be a complete exhibit of highway materials and equipment. A. Lee Grover, secretary of the New Jersey State Highway Commission, Trenton, is secretary of the association.

MISSOURI HIGHWAY ENGINEERS

The Highway Engineers' Association of Missouri will hold its 21st annual convention at Kansas City, Mo., February 22-24. W. M. Symon is manager of the convention bureau of the Kansas City Chamber of Commerce.

ENGINEERING SOCIETY ELECTIONS

Illinois Sections, A. S. C. E.

The Illinois Section of the American Society of Civil Engineers held its annual meeting in Chicago on Jan. 13, and elected as officers for 1928: President, Jerome A. Moss; vice-presidents, Rufus W. Putnam and Willis J. Dean; secretary, W. G. Zimmerman, American Bridge Co., Chicago.

American Institute of Consulting Engineers

At the annual meeting held in New York, Jan. 16 and 17, John F. Coleman, of New Orleans, was elected president, Alten S. Miller, of New York City, vice-president, and P. W. Henry secretary and treasurer (re-elected). The following were elected to the council for the term expiring January, 1931: Howard C. Baird, New York City; Baxter L. Brown, St. Louis, Mo.; and E. P. Goodrich, New York City.

Indiana Engineering Society

W. C. Mabie, chief engineer of the Indianapolis Water Co., has been elected president of the Indianapolis section, Indiana Engineering Society, Earl Carter, vice-president, H. J. McDargh, secretary and treasurer, and H. M. Starling and Paul R. Jordan, trustees.

Ohio Engineering Society

At the 49th annual convention of the society held at Columbus, O., Jan. 4 and 5, Frank W. Jennings, Columbus, was elected president; Atlee M. Wise, Canton, first vice-president; George E. Carr, Columbus, second vice-president; and Carl L. Van Voorhis, secretary-treasurer.

American Engineering Council

At the meeting held in Washington, D. C., Jan. 9-11, officers were elected as follows: President, A. W. Berresford, Detroit; vice-president, Gardner S. Williams, Ann Arbor, Mich., and I. E. Moultrop, Boston; treasurer, Harrison E. Howe, Washington.

PERSONALS

H. H. Gerstein, assistant engineer, has been appointed to succeed Arthur E. Gorman, chief sanitary engineer of the division of Water Supply Control Department of Public Works, Chicago, Ill.

George A. Carpenter, president of the New England Water Works Association, and City Engineer of Pawtucket, R. I., died December 15, after an illness of about two months. Mr. Carpenter was 64 years old and had been city engineer since 1891. He was also active in other engineering work, and was a member of numerous engineering societies, including the American Society for Municipal Improvements and the American Society of Civil Engineers.

W. G. Stromquist, formerly sanitary engineer of the Department of Health, Memphis, Tenn., has been appointed director of the bureau of sanitary engineering of the Jefferson County Board of Health, Birmingham, Ala.

CIVIL SERVICE EXAMINATIONS

Junior Engineer.—Applications to February 25. To fill vacancies in various branches of the Federal government. Entrance salary $1,860. Assembled examinations will be given in the following optional subjects: Aeronautical engineering, agricultural engineering, chemical engineering, civil engineering, electrical engineering, mechanical engineering, mining engineering, naval architecture and marine engineering, and structural steel and concrete engineering.

The duties of these positions are to perform such work as routine testing, inspection of engineering material, drawing up plans for minor projects, preparing specifications for engineering material or apparatus, performing field work, making computations, preparing maps, assisting in conduct of experimental research tests, compiling reports, and handling technical correspondence.

Competitors will be rated on general physics, mathematics, general engineering, and the optional subject selected.

Draftsmen, Architectural, Structural, Electrical and Topographic. Applications to February 7 for Principal and Senior draftsmen at salaries of $200 to $250 per month. To fill vacancies in Panama Canal and similar services. Non-assembled examination. U. S. Civil Service Commission, Washington, D. C.

Design Draftsman (Topographic and Subsurface). Applications to February 28. To fill a vacancy in the Public Works Department, Marine Barracks, Quantico, Va., and other vacancies. Salary $8.05 per day. Non-assembled examination. The duties will consist of the drawing of maps of all kinds, both topographic and subsurface, from original field notes, with calculations as required; designing of pavements, walks, and roads; the laying out and computing of grading, filling, and dredging; and underground service piping, layouts, etc.

BOOK REVIEWS

Water Purification Plants and Their Operation. By Milton F. Stein. 316 pages, 105 ills. John Wiley & Sons, Inc. $3. The third edition of this book, familiar to most waterworks men, is brought up to date, and somewhat enlarged. In the new edition, as in the previous ones, the intention has been to provide little more than the essential information required by a plant operator, discarding matter that is interesting but

non-essential. Appendices on analysis of coagulants, standard solutions, the numerical interpretation of bacterial lists, the colloidal theory, and Hydrolgen-ion concentration provide recent data on these subjects.

Parks. A Manual of Municipal and County Parks. L. H. Weir, Editor. A. S. Barnes & Company, New York, 1200 pages, 346 illustrations. 2 Volumes. $15.00

The twenty-one chapters discuss the following subjects; Old Parks and New, The Why of Parks, General Planning of a Park System, General Municipal and County Park Planning, Notes on Elements in the Design of Park and Recreation Areas, Construction Notes, General Administrative Control of Parks, Park Financing, The General Executive Organization of a Park Department, Office Organization and Management, Park Engineering Division, Maintenance, Horticultural Division, The Recreation Service Division, Park Policing, Park Lighting, Park Sanitation, Zoological Parks and Aquariums, Botanical Gardens, Educational Publicity, The Training of Park Executives and General References to Literature on Parks.

MUNICIPAL AND OTHER PUBLIC REPORTS

A Physical Study of the Mokelumne Pipe Line. By Lloyd T. Jones and Walter S. Weeks, University of California Press. This bulletin presents a complete report of the work done by the above professors on the calculation and measurements of stresses of the Mokelumne Pipe Line. It is the first and only treatise on pipe line stresses and has been published by the University of California Press so as to make these data available for all who may be interested in pipe line construction, particularly in welded lines.

INDUSTRIAL NOTES

P. C. Brooks has been elected a vice-president of Fairbanks, Morse & Co., Chicago, Ill. Mr. Brooks has been connected with the organization for twenty-nine years and is president of E. & T. Fairbanks & Co., and vice-president of the Canadian Fairbanks-Morse Co., Ltd., both subsidiary organizations.

George L. Pollock, vice-president and treasurer of the Burnside Steel Foundry Co. since its organization, has resigned as of January 1st to become vice-president of The Nugent Steel Castings Company, Chicago.

N. Emory Bartlett, and Y. F. Hardcastle, recently elected vice-presidents of the Pennsylvania Salt Mfg. Company, have also been elected vice-presidents of the Michigan Electrochemical Company, and the Tacoma Electrochemical Company. William D. LeBar has been appointed superintendent of the plant of the Pennsylvania Salt Mfg. Co., at Wyandotte, Michigan, succeeding Y. F. Hardcastle in that position.

The American-LaFrance Fire Engine Company, Inc., of Elmira, N. Y., has acquired the assets and good will of the Foamite-Childs Corporation, of Utica, N. Y., and the business of the two companies will be combined under a single corporate identity, the name of which will be the American-LaFrance and Foamite Corporation. This corporation will maintain sales offices and engineering representatives in all the principal cities of the United States and Canada. Affiliated companies will operate in foreign countries.

Paradon Manufacturing Company, Arlington, N. J., announce the following changes in its sales organization: Paul M. Nickerson, formerly on sales and service work from the main office, has been appointed as sales representative for the New England states and the state of New York, with the exception of the vicinity around New York City. Thomas M. Zimmerman, formerly of the State Highway Commission of Pennsylvania, will take care of sales and service work for the states of New Jersey, Eastern Pennsylvania, Delaware and Maryland.

The "Highway Engineering Bureau" has been formed, with offices in the National Press Bldg., Washington, D. C., to provide consulting services in highways, transportation and associated industries. Chas. M. Upham is president, and Fred E. Schnepfe, vice-president; other advisory engineers are Albert T. Goldbeck, Prevost Hubbard, Maurice Holland, Fred A. Reimer, Henry G. Shirley, Earl Stafford, Wm. A. Van Duzer, Dr. J. A. L. Waddell, and Shortbridge Hardesty.

The Pennsylvania Salt Manufacturing Company has announced the following changes in organization as of January 1st, 1928. N. Emory Bartlett, who has been with the company since November, 1893, has been elected a vice-president, and will also continue his duties as general sales agent. Y. F. Hardcastle, who has been connected with the Wyandotte Plant since January, 1910, has also been elected a vice-president, and will have charge of the manufacture of the chlorine products at the present plants at Wyandotte and Menominee, Michigan, and will also superintend the construction of the new plant at Tacoma, Washington.

Hendrick Manufacturing Company, Carbondale, Penna., manufacturer of Mitco Interlocked steel grating, Mitco "Shur-Site" stair treads and Mitco "Armorgrids," announces the opening of a Chicago district office, 223 Railway Exchange Building, Chicago, in charge of Lon Sloan.

Van Cortright Mekeel, formerly connected with Taylor-Wharton Iron & Steel Co. of High Bridge, N. J. in capacities of special research investigator, mechanical engineer and sales engineer, has resigned to accept a post as special representative of The Nugent Steel Castings Co., Chicago, Illinois.

Link-Belt Company announces the appointment of four vice presidents, as follows: George P. Torrence, with headquarters at Indianapolis, in general charge of Indianapolis operations and sales of Indianapolis plant products; George L. Morehead, Philadelphia, in charge of Eastern operations and sales; Frank B. Caldwell, in charge of the Chicago plant and sales offices tributary thereto; W. C. Carter, in general charge of production at all plants with headquarters at the general office of the company, 910 S. Michigan Ave., Chicago.

The City of Peoria, Ill., recently bought ten 1½-ton Indiana Model III motor trucks, equipped with 3-yard garbage bodies operated by Wood hydraulic underbody hoists. The trucks are provided with roll-back tarpaulins for covering the bodies. In line with the policy of the city to secure the maximum possible cooperation from the citizens, these trucks are all lettered boldly with "Help Us Keep Your City Clean."

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

LINK-BELT "GRIZZLY" LOADER

The Link-Belt Company, Chicago, Indianapolis and Philadelphia, is introducing a new snow loader or rather a new application of their standard Crawler Tread bucket loader in the handling of snow. It is an "all-purpose" machine, since the same model will handle snow, sand, stone, gravel, coal and all loose materials. It is possible to extend the skirt boards on both sides the full length of the bucket boom. Even with wet snow, a continuous stream of snow can be handled in the buckets, and an almost continuous flow maintained over the discharge chute. In handling snow, only one operator is necessary on the platform, with, at times, one man on each side of the machine to clean up. This is a marked saving of labor. The feeder and guard, or scoop, at foot of the bucket boom, clears the way for the crawler treads. It is claimed the loader will turn in its own length.

TRACTOCRANE

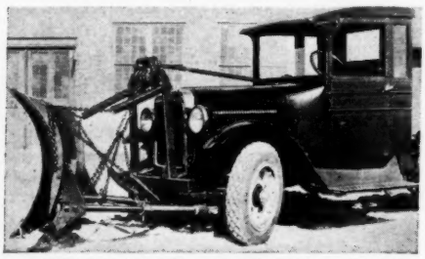
The Vergan-Schmidt Co., Champaign, Ill., manufactures the Tractocrane, which is a portable crane unit built with either a Fordson or McCormick-Deering tractor. It is mounted on rubber tired wheels, semi or full crawler traction, and has 20 or 25-ft. boom, ⅓ or ½-yard clamshell bucket, ⅓-yard shovel boom, ⅓-yard trench hoe, fall block, skimmer scoop, and pile-driving attachments are available as standard equipment. All attachments are interchangeable. This machine is being used for road building, contracting and industrial and public utility work, on grading, excavating, pile driving, hoisting, back-filling and trenching. Among its special features are a self-contained generator and magnet for handling pipe, pig iron, scrap and similar materials. Weight is from 8 to 10 tons; wheelbase, 137 inches; width, 8 feet 6 inches; speed from 1½ to 10 miles per hour. The short turning radius permits use in constricted places.

VERGAN-SCHMIDT TRACTOCRANE

GETTELMAN HIGH-SPEED SNOW PLOW

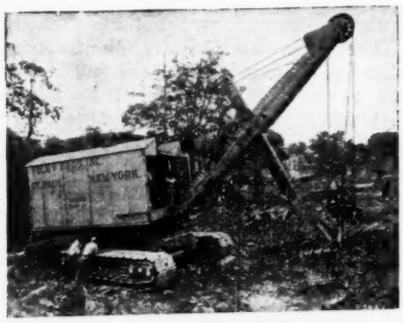
The Heil Co., Milwaukee, Wisc., is now placing the Gettelman high speed snow plow on the market. It is claimed to be the lightest, fastest, and strongest trip blade plow now manufactured. Tests show it will operate in dry snow at speed up to 35 miles per hour. It can be installed on any truck in 2 hours, and, if the attachments are in place, much more quickly.

The plow has three positions relative to the road, one a predetermined position to the right, one to the left and a position square across the front of the truck. This last position is used when bulldozing the snow at road intersections. The first two positions are secured through the use of tubular push arms attached to the front axle, with a universal axle attachment, and the arms telescope so that the angle of the blade may be adjusted to either position.



GETTLEMAN HI SPEED SNOW PLOW

One of the distinctive features of this equipment is the tripping action of the blade. It safeguards the blade when traveling over small obstructions such as rail tracks, stop boxes and manholes in the street. When the blade hits obstructions which would damage an ordinary plow, it pivots on the push arm attachment toward the horizontal position, until it passes the object. Springs then bring it back to the operating position.



ELECTRIC DRIVEN SHOVEL

SILENT ELECTRIC SHOVEL

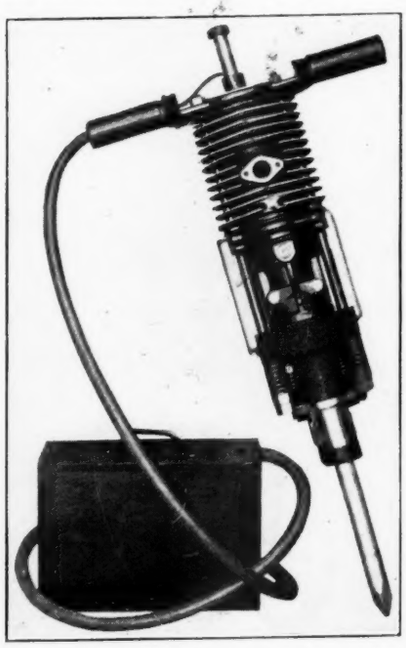
The Marion Steam Shovel Co., Marion, O., in cooperation with the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa., has developed an electrically operated shovel, known as the model 37. A ¾-yard shovel of this type is in use by Foley Bros., contractors, on a large job at Fort Lee, on the New Jersey side of the Hudson River Bridge.

The motor is operated by variable voltage control. This affords all the speed range and all the flexibility of steam but does away with noise, and eliminates smoke. There is also said to be an economical side to this modern electrical shovel, as no fireman is necessary, there is no fuel to haul and handle, no problem of water supply, and no lost time waiting for steam pressure. When, as is the case in the Fort Lee job, it is necessary to operate the shovels in winter, the electric shovel eliminates the dangers of boiler and steam pipes freezing.

GREYHOUND TRIPLE ACTION ROAD BUILDER

The Banting Mfg. Co., Toledo, O., manufacture the Greyhound Triple Action road builder, which scarifies, grades, and rolls in one operation, and with only one operator. Mechanical devices for hoisting and lowering the scraper blade are operated from the driver's seat. The

grader blade can be changed to any angle, or set down to deliver dirt from either side. Power is distributed equally to all four wheels, the arrangement permitting the machine to travel over uneven roads without undue strain. There are two speeds forward, giving rates of



RODAX

1¾ and 4 miles per hour, and one reverse, giving 3 miles per hour. Power is supplied by a 60 horsepower, 4-cylinder motor.

BAY CITY SNOW SCOOP

The Bay City Dredge Works, Bay City, Mich., has designed a special snow handling bucket for attachment to any standard Bay City tractor shovel. This bucket, which can be attached in less than an hour, is a special over-size bucket, shaped particularly to handle snow on streets and along curbs and gutters. The face of the bucket is 42 inches wide at the lip, tapering to 44 inches at the bottom, so as to insure easy dumping of packed snow. The capacity is 1 cubic yard and, as the tractor shovel has an operating speed of four or five trips per minute, it is capable of very rapid work.

A community owning a tractor shovel can use it throughout the year on excavation and material handling work, and at a cost of less than $300, provide themselves with an excellent snow loader.

BAY CITY SNOW SCOOP

"RODAX"

The Milwaukee Gas Tool Corporation, Milwaukee, Wisconsin, has developed and perfected a new labor-saving device for use in pavement breaking. This machine has been tried out for the past two years, a number of them have been in operation working under the most severe conditions on all types of jobs.

This machine will be known as "Rodax." It is a gasoline hammer and is claimed to be the most economical concrete breaker now on the market. It is different radically from any other equipment now in use. It is in reality a gasoline hammer of a new type which has no fly wheel, connecting rods, cam shaft or bearings, and its simplicity and rugged construction is said to make it practically fool-proof. The piston operates as the hammer, striking more than 1,000 blows per minute. These blows are transmitted through an anvil direct to any standard cutting tool which may be used. A push on the plunger at the top of the machine will start it immediately.

The entire unit weights but 85 pounds and will operate all day on two gallons of gasoline. It requires no outside equipment to operate it but is a self-contained unit. This machine will be manufactured by the Le Roi Company of Milwaukee, Wis., for the Milwaukee Gas Tool Corporation, which will market it through contractor equipment distributors.

BUFFALO RAW SEWAGE PUMP

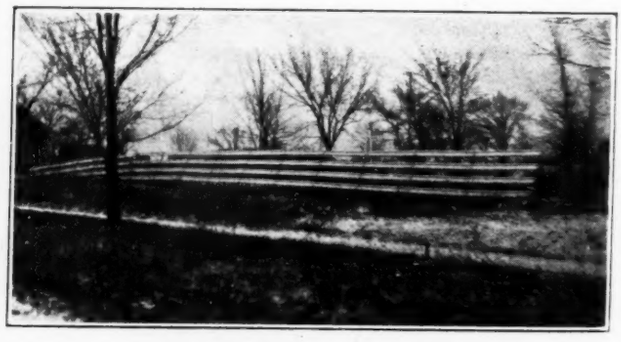
The Buffalo Steam Pump Co., Buffalo, N. Y., have brought out a non-clogging sewage pump, which, it is claimed, will handle any material that will pass the eye of the impeller. It will take care

BUFFALO SEWAGE PUMP

of rags, pieces of clothing, and sticks. The impeller is of cast iron (bronze, if desired), and has no projecting surfaces. Clean out doors are provided. These pumps are furnished in both vertical and horizontal types, in normal capacities from 500 to 4,800 gallons per minute; the smallest size will handle solids up to 3 inches in diameter, and the largest size up to 10 inches. These pumps are also suitable for handling liquids of varying consistency, containing solids, strings, or rags. Where the service requires, special composition metal may be used.

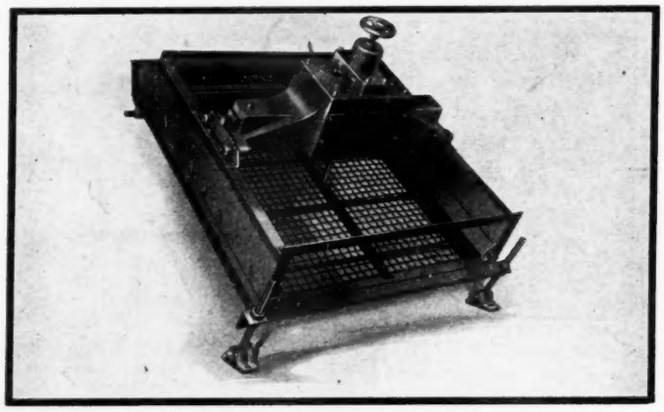
NORTHFIELD PRESSED STEEL SNOW FENCE

The Northern Iron Co., Northfield, Minn., manufactures pressed steel snow fence, which is claimed to cost



PRESSED STEEL SNOW FENCE

less than half of any other steel fence, and less than twice as much as wood fence. It is said to be more economical to haul and install, more compact, easier to take down, and very durable. Four times the footage can be hauled per load. The height is 4 feet, the panel length 8 feet, and the post 2-inch by 1½-inch angles 6 feet long. The coverage is 50 per cent. The weight, including posts and braces is about 3½ pounds per lineal foot.



HUM-MER ELECTRIC SCREEN

It is stated that this fence will clear itself of snow twice as deep as will any other fence, and that the posts may be placed despite frozen ground.

THE HANSON EXCAVATOR

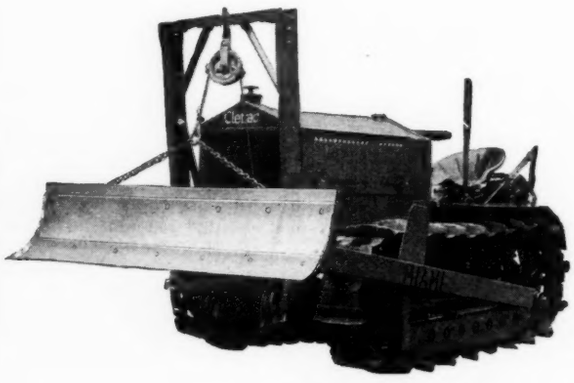
The Hanson Clutch and Machinery Co., Tiffin, O., manufactures a ⅜-yard excavator, which is claimed to possess exceptional sturdiness, balance and simplicity. It is convertible to shovel, clamshell, trench hoe, dragline or crane. It is light, and easily moved from place to place. All controls are within reach of the operator's seat, and all power is transmitted through Hanson friction clutches. It is claimed that, due to its light weight, this is an exceptionally fast machine. Power is furnished by a McCormick-Deering motor. The speed is 2½ miles per hour, and the weight 21,000 pounds.

HUM-MER ELECTRIC SCREENS

The W. S. Tyler Co., Cleveland, O., manufacture the Hum-mer electric screen, which operates on less than one horse power, but is claimed to have several times the capacity of rotary, shaking or bumping screens. The heavy duty vibrator produces 1,800 impulses per minute, keeping the stone constantly agitated, and giving the smaller particles every opportunity to pass through the openings. The intensity of the vibration, and the angle at which the screen is operated can be adjusted quickly; and one man can change the screen in 20 to 30 minutes. There is no bearing, cam or eccentric that requires lubrication. It is claimed that improved or increased product, and lower labor and maintenance costs are secured by the use of Hum-mer screens.

MIAMI BULLDOZER

The Miami Trailer-Scraper Co., Troy, O., has just brought out the Miami Bulldozer or front blade back-filler. This piece of equipment is designed for attachment to the Model 20-K Cletrac tractor. It is a power operated, front blade back-filler, and is claimed to be a fast-operating unit. The blade is controlled by the Miami power winch, which is attached to the power take-off on the rear of the tractor. The positive control of the blade enables the operator to raise or lower the blade, as desired, instantly. The tractor driver engages and disengages the clutch for raising or lowering the blade. This can be done with the tractor in either forward or reverse motion.



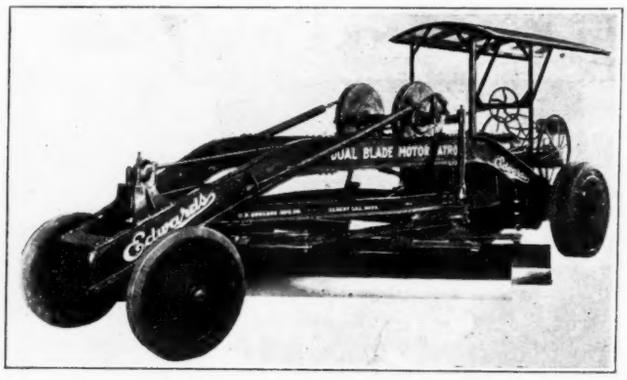
MIAMI BULLDOZER

On an actual test, one man with this outfit back-filled a sewer trench 3 feet wide and 6 feet deep at the rate of 100 feet per hour. The unit is also suited for levelling purposes, small grading operations, spreading gravel, moving snow and pushing dirt over fills.

EDWARDS DUAL BLADE MOTOR PATROL

The C. D. Edwards Mfg. Co., Albert Lea, Minn., have just brought out a dual blade motor patrol which, it is claimed, has a unique ability to remove and keep the road free from "corduroy." The power unit is a 10-20 McCormick-Deering tractor; the frame is of 10-inch

THE HANSON EXCAVATOR



EDWARDS DUAL BLADE GRADER

channel giving great rigidity. All wearing parts are bushed or fitted with adequate take-ups.

It is claimed that by cutting one-half of the load with the front blade and the balance with the rear blade, the machine has 80 per cent. less tendency to vibrate than when the whole load is cut with one blade only. It is also pointed out that with dual blades, one blade acts as the wheel base for the other thereby preventing either the front or the rear blade from dropping in the low holes since the blades are mounted rigidly to one heavy high-carbon beam.

Both blades are always parallel and can be angled at 45 degrees to either the right or left. The blades are also extensible so that the machine can cut a ten-foot swath or a thirteen-foot swath as desired. It is recommended for heavy spring rebuilding work that the two blades be placed one behind the other.

The weight of this machine with cab and without scarifier is 13,100 pounds. The blades will extend outside of the wheels on either side forty-six inches.

TOLEDO TORCH

The Toledo Pressed Steel Co., Toledo, O., manufacture the Toledo Torch, which is a safety light for construction purposes. It will burn through wind and rain for more than 24 hours on one filling of about seven-tenths of a gallon of the lower grades of fuel, as light furnace oil. Weight, unfilled is 5½ pounds; a cast iron counterweight, electrically welded in place, makes the torch self-righting at all times.

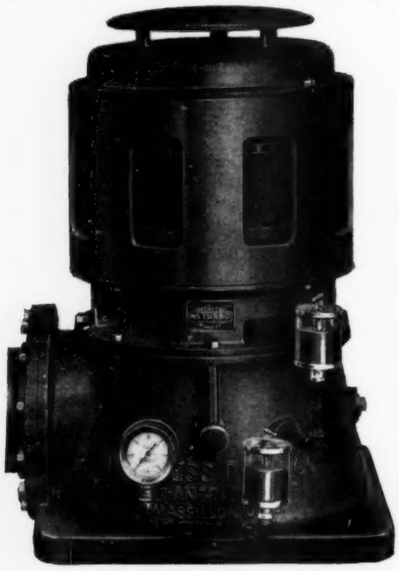
MOTURBO DEEP WELL PUMP

The Peerless Pump Co. of Los Angeles, Calif., and Massillon, O., manufactures the Moturbo deep well pump which has a wide range of capacity and is designed for high heads and deep pump settings. It is stocked in four sizes from 7½ to 75 h.p. vertical motor drive. Larger sizes can be furnished.

The motor rotor is mounted direct on the shaft doing away with the usual flexible coupling and insuring accurate alignment. The motor may be removed and replaced with a pulley that has the same bearing arrangement. This is easily and quickly accomplished without disturbing any other part of the unit or the impeller adjustment.

Cold oil lubrication is a feature. The oil well is so located in the base of the pump head that the discharged water flows around it, keeping the oil at a low temperature. Therefore the oil retains its body and lubrication qualities. The radial bearing which is located near the top of the motor is fed with a constant stream of cold oil by means of a spiral vane attached to the pump shaft that picks up the oil and forces it up and over the bearing from whence it flows back to the oil well. This not only provides for a rapid and continuous circulation of oil to both the vertical thrust and radial bearing, but eliminates the danger of oil saturation of motor windings.

The enclosed pump shaft bearings are oil lubricated, requiring a minimum quantity of oil. There are no stuffing boxes, top or bottom.



"MOTURBO" PUMP

INTERFLASH TRAFFIC CONTROL SIGNAL

The Interflash Signal Corporation, New York City, manufacturer of flashing signal lights for marine, aviation and traffic purposes, has developed and placed upon the market a new traffic control signal of the all-electric type.

The new signal unit is of the three-light—red, amber and green—type. To meet the demands of all kinds of installations, the signal is furnished in 1-way, 2-way, 3-way and 4-way light indications. Its construction is such that it may be mounted either upon standards or suspended overhead on a cable or mast arm.

The housing or body of the signal is made of cast aluminum alloy throughout, as are likewise lens, reflector holders and sun visors. The lenses used are the approved diffusing rounded type, each 8⅜ inches in diameter. The light source of the signal is the standard 60-watt traffic signal lamp, whose rays are directed by a silvered polished glass reflector. Each of the signal indications is an independent unit and the renewal of signal lamp and other necessary replacements or adjustments can be made by merely opening the section affected and such changes can be made without disturbing in any way the operation of the signal. The Interflash control signals are finished in dark green Duco enamel and shipped completely assembled ready for mounting as required.

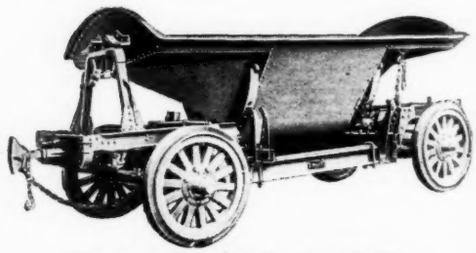
THE INTERFLASH TRAFFIC CONTROL SIGNAL

ANDERSON OIL ENGINES

The Anderson Engine & Foundry Co., Anderson, Ind., manufactures Anderson oil engines, which are claimed to have high efficiency, exceptional strength, slow moving parts, and large safety factors. They are of the vertical 2-cycle type. Piston speed does not exceed 750 feet per minute, and flywheel speed 4,625 feet. These engines are guaranteed not to vary more than 4 per cent. in speed from no load to full load.

TROY TRAILERS FOR GARBAGE AND ASHES

The Troy Trailer and Wagon Co., Troy, Ohio, manufactures Troy Trailers, which are adapted to a wide range of hauling work. The drop frame trailer is especially designed to meet the requirements of ash and garbage collection work. The loading edge of the trailer is only 60 inches high, and the short wheel base allows a very short turning radius, which is frequently necessary when turning into alleys. The net capacity is 4,100 pounds, or 4 to 4½ yards with a rounded load. Team tongues are available for use with these trailers so that they may be handled by horses on collection, later to be picked up in trains by tractors and hauled to the point of disposal. This method is claimed to reduce the cost more than one-half.



TROY DROP-FRAME TRAILER